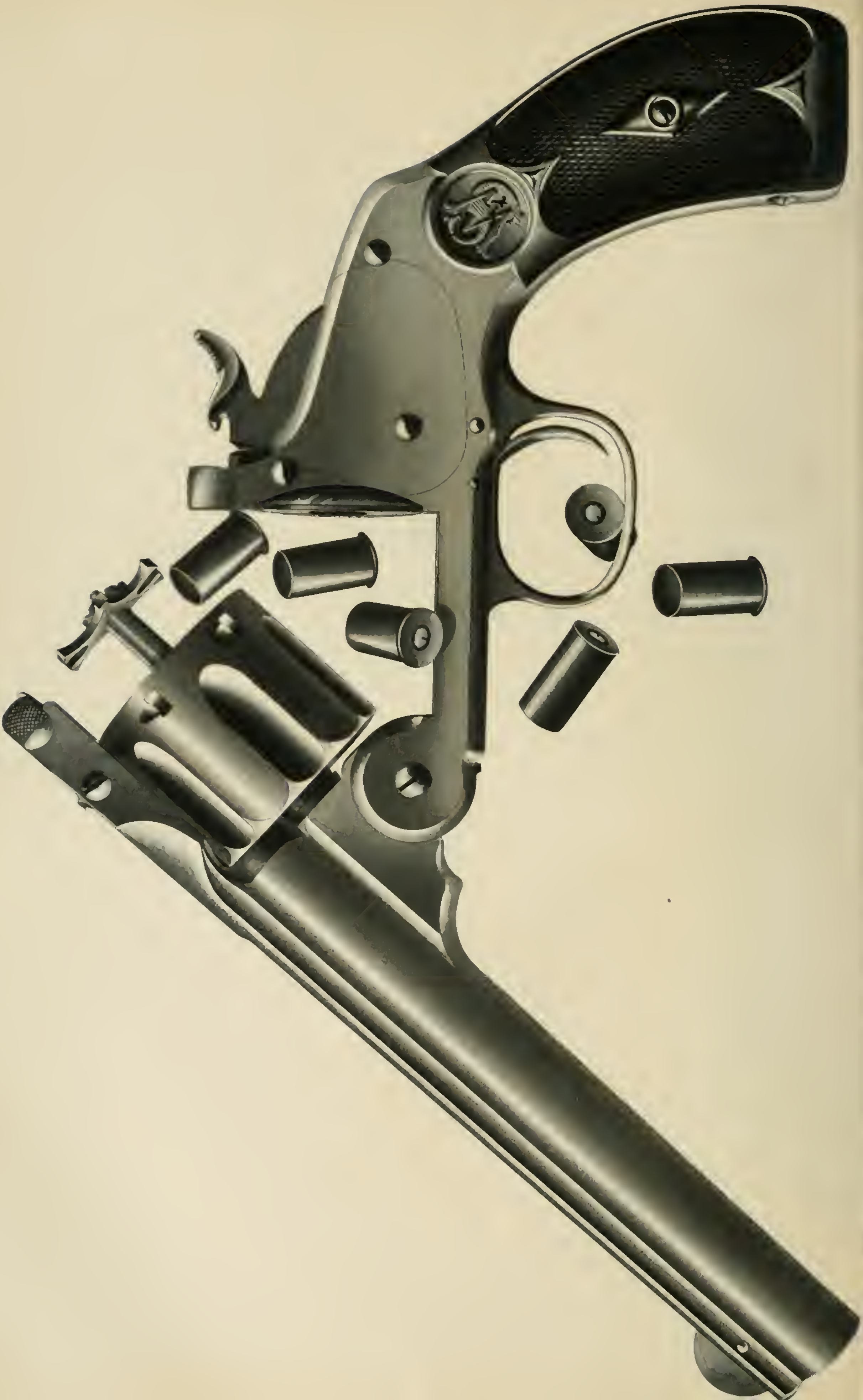

FARROW'S
MILITARY ENCYCLOPEDIA

A DICTIONARY OF MILITARY KNOWLEDGE

ILLUSTRATED

WITH MAPS AND ABOUT THREE THOUSAND WOOD ENGRAVINGS

BY

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"What is obvious is not always known, and what is known is not always present."—JOHNSON.

COMPLETE IN THREE VOLUMES. VOLUME I.

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DEDICATED

TO THE

NATIONAL GUARDS OF AMERICA

In Appreciation of their Enterprise and Valor

AND AS A TRIBUTE OF HOMAGE

TO

GALLANT SOLDIERS.

PREFATORY NOTICE.

The design of this work is that of a Library of Military Knowledge for the People—not a mere collection of elaborate treatises in alphabetical order, but a work to be readily consulted as a Dictionary on every military subject on which people generally require some distinct information—no article being longer than is absolutely necessary. The several topics are not handled with a view to the technical instruction of those who have to make a special study of particular branches of military knowledge or art. The information given may be characterized in many instances as *non-professional*, embracing those points of the several subjects which every intelligent man or woman may have occasion to speak or think about. At the same time every effort is made that the statements, so far as they go, shall be precise and scientifically accurate.

Although about 30,000 subjects have been compiled from the various publications and records of the War Department, Foreign War Offices, and Military Works of reference, more than 5000 original articles have been prepared by specialists in America and abroad. While the Tactics, Ordnance, Gun Machinery, Implements, and Equipments of all ages and of all military powers have been fully described and illustrated under appropriate headings, a complete system of cross-references enables the military student to quickly locate several hundred articles pertaining to the general subject under investigation. Thus, under the article Magazine Gun will be found the following references: *Boch*, *Buffington*, *Bullard*, *Burgess*, *Burton*, *Chaffee-Reece*, *Clemmons*, *Colt*, *Dean*, *Elliott*, *Franklin*, *Hunt*, *Lee*, *Lewis-Rice*, *Miller*, *Remington*, *Russell*, *Spencer-Lee*, *Springfield-Jones*, *Tiesing*, *Trabue*, *Whitney*, and *Winchester Magazine Guns*. Under each of these articles are references to articles describing and illustrating all other arms of the respective classes. The Compiler has made special effort to set forth in detail the numerous decisions, rendered by the War Department and Tactical Department at West Point, on the tactical points raised and submitted from time to time by the Officers of the Army and National Guard. The descriptions and illustrations of more than 500 varieties of Gun Machinery, Steam Hammers, Cranes, etc., constitute a novel feature of the work to be appreciated by those wishing to investigate the subjects of construction, testing, etc.

The original plan has been strictly adhered to throughout; and if, as the work proceeded, there has been any change in the method or quality of the execution, it may at least be affirmed that the change has not been for the worse. After some experience, it became easier to find the person specially qualified to write a particular kind of article, and thus the circle of contributors became widened, and the distribution of the work more specialized. It was also seen to be desirable, in regard to certain classes of subjects, to admit a rather ampler selection of heads. This has been effected without increasing the scale of the work, not so much by less full treatment of the subjects, as by increased care in condensing the statements and omitting everything superfluous. A great quantity of matter pertaining to Foreign Armies has been introduced in this work, so as to enable the military student to compare the organization, arms, etc., of all armies with those of his own service. The Encyclopedia contains also descriptions of ancient armor, and of arms, lately in use, which have become obsolete, as it may be of some interest to follow the changes which have taken place in the mode and means of fighting from the earliest period down to the present time. The insertion of veterinary terms and of remedies for the common complaints of horses will be found useful under conditions where a Veterinary Surgeon is not available, as is often the case in detached parties of Cavalry. A description of all tools and machines found commonly in workshops may prove acceptable to Departmental Officers on their first joining Government Manufacturing Establishments.

Of the Sciences, the least adapted to encyclopedic treatment is Mathematics. All terms of common occurrence in Gunnery, Reconnoissance, etc., however, have been introduced, and a brief exposition of the subjects given, as far as could be done in an elementary way. Natural Philosophy has received ample attention, and all the leading doctrines and facts of general interest will be found under their appropriate heads, treated in a popular way, and divested as far as possible of the technicalities of mathematics. Chemistry, some knowledge of which is becoming daily more indispensable in all departments of military life, receives a comparatively large space. Prominence has been given to those points of the subject that have either a direct practical military bearing or a special scientific interest. During the progress of the work, several changes in the nomenclature and notation of the Science have come into general use; these have been duly noted under the appropriate headings. The new and far-reaching doctrines of the Corrèlation of Forces and the Conservation of Energy have produced vast changes in the nomenclature and classification of the various sections of Military Physics; while the more complete investigations into the phenomena and laws of light, heat, motion, and electricity have created virtually new sections, which must find a place in any adequate survey of scientific progress. Mechanical invention has, indeed, so kept pace with the progress of Military Science and the Art of War, that in almost every department of Physics improved machines and processes have to be described, as well as new discoveries and altered points of view. The manufacture of gunpowder and high explosives is a signal instance of the extent to which in our day scientific discovery is indebted to appropriate machinery and instruments of observation and analysis. These extensive changes in Physics involve corresponding changes in the method of their exposition. The scientific department of the work is consequently treated in all its branches in the most effulgent manner, and over 1000 very fine engravings are used for the purpose of illustration.

True to its projected plan as a LIBRARY OF MILITARY KNOWLEDGE FOR THE PEOPLE, this Encyclopedia will be found to be especially rich in notices of miscellaneous military matters. Some of the subjects introduced might perhaps be considered beneath the dignity of a book aspiring to a more severely scientific character; but all of them are, if not instructive, at least curious or entertaining, and likely to occur in the course of reading or conversation. During the progress of the work, the Compiler has received numerous assurances from parents as to how highly it was prized, even though only partly issued, by their sons at Military Schools, as a repertory of the kind of things they are constantly in search of and often puzzling their elders about. This use of the Encyclopedia has been steadily kept in view; and it is gratifying to learn that it is found efficiently to serve the purpose intended.

In conclusion, the Compiler asks the indulgence of Military Critics wherever errors or discrepancies have crept into this work, and begs to acknowledge the valuable help obtained from the works of many authors, both military and scientific, through the courtesy of Messrs. John Wiley & Sons and Mr. D. Van Nostrand, publishers, and the assistance he has received from various friends. To General Stephen V. Benét, Chief of Ordnance, United States Army, he is especially indebted for courteous assistance in the preparation of the work. To economize in space and to avoid crowding up the text, the name of the author from whom information has been derived has not been inserted after each quotation; but a list of all works which have been consulted, and from which extractions have been made, will be found at the commencement of each volume.

It is intended, with the view of meeting the changes which are constantly taking place in the *matériel* of armies, new processes, military inventions, etc., to issue a Supplement at suitable intervals, containing all alterations and additions.

United States Military Academy
West Point, New York, 1885

LIST OF WORKS CONSULTED OR EXTRACTED FROM.

Aide-Mémoire de l'Officier d'État-Major. M. de Rouvre.
Aide-Mémoire to the Military Sciences.
Almanach de Gotha, 1876.
American Universal Cyclopedia.
Ammunition, Treatise on, 1874. Published by English authority.
Analytical Digest of the Military Laws of the U. S. Scott.
Aperçus em quelques Details de la Guerre. Bugeand.
Archives, German Military.
Armies of Asia and Europe. Upton.
Arms and Armour. Boutell.
Army and Navy Pension Laws. Mayo and Moulton.
Army Circulars. Published by the English War Office.
Art and Science of War. Wheeler.
Artillerist's Handbook of Reference. Well and Dalton.
Artillerist's Manual. Gibbon.
Artillerist's Manual, 11th edition. Griffiths.
Artillery and Infantry. Kingsbury.
Artillery, Dictionary of. Cotty.
Artillery Exercises, Field, Changes in, in 1873. Phillpotts.
Artillery Institution Papers.
Artillery, Lectures on. Owen and Dames.
Artillery, Modern. Owen.
Artillery, Treatise on. Boxer.
Art of War. Graham.
Art of War. Jomini.
Astronomical Atlas. Milner.
A Treatise on the Law of Evidence. Greenleaf.
Baker's Elements of Mechanism.
Balfour's Encyclopedia of India.
Battles of the Revolution. Carrington.
Blue Books (Parliamentary).
Bourne on the Steam Engine.
Brande and Cox's Dictionary of Science, Literature, and Art, 1875.
Campaign in Germany, 1866. Prussian Staff.
Campaigns of the Army of the Potomac. Swinton.
Cape's Mathematics.
Cavalry Manual. Ainslie.
Chambers's Encyclopedia.
Change of Matériel. Published by the English War Office.
Chemistry as applied to the Arts and Manufactures. Muspratt.
Chemistry, Handbook of. Abel and Bloxam.
Chemistry, Manual of. O'Shaughnessy.
Classical Dictionary. Smith.
Commentaries, with Notes. Blackstone.
Conférences du Ministre de la Guerre (France).
Conférences Militaires Belges.
Construction of Dwelling-houses.
Consulate and the Empire. Thiers.
Courts-Martial. De Hart.
Courts-Martial. Macomb.
Cross' and Hetzel's Military Laws of the United States.
Cummer Steam Engine.
Customs of Service for Non-commissioned Officers and Soldiers of the Army. Kautz.
Customs of Service for Officers of the Army. Kautz.
Defense of Military Outposts. Jebb.
De la Tactique des Trois Armes; Infanterie, Cavalerie, Artillerie. Decker.
Dictionary, Handy, of Military Terms. Knollys.
Dictionary, Military and Naval. Burn.
Dictionary, Military and Naval. James.
Dictionary of Arts and Sciences. Francis.
Dictionary of Arts, Manufactures, and Mines. Ure.
Dictionary of Every Days Difficulties. Shilton.
Dicionary of Greek and Roman Antiquities. Smith.
Dictionary of Military Science. Campbell.
Dictionary of Science, Literature, and Art. Brande.
Dictionary of the English Language. Johnson.
Dictionary of the English Language. Nuttall.
Dictionary of the English Language. Smart.
Dictionary of the United States Army. Gardner.
Dictionary, Philosophical. Hutton.
Dictionnaire Militaire Portatif. Le Grand.
Dictionnaire Portatif et Raisonne. Couturier.
Die Lehre Vom Neueren Festungskrieg. Rüstow.
Dienst-Vorschriften der Königlich Preussischen Armee. Von Helldorff.
Digest of Decisions of Federal Courts. Peters.
Digest of Laws of the United States. Dunlop.
Digest of Laws of the United States. Gordon.
Digest of Military Laws. Mordecai.
Digest of Opinions of the Judge-Advocate General. Winthorp.
Electro-Ballistic Machines. Benét.
Elementary Lectures on Military Law. Tulloch.
Elementary Principles of Fortification. Hyde.
Elements of International Law. Wheaton.
Elements of Military Arts and Sciences. Halleck.
Encyclopedia Britannica (1875).
Encyclopédie Militaire et Maritime.
Field-book of the Revolution. Lossing.
Field Exercise and Evolutions of the Army.
Field Exercise (English), 1870.
Field Fortification: a Manual of Military Sketching and Reconnaissance. Published by English authority.
Field Fortification. Macaulay.
Field Fortifications. Mahan.
Field Fortifications. Wheeler.
Fortification and other Military Subjects as carried on at the Royal Military Academy, Woolwich.
Fortification. Arnetti.
Frederick the Great. Carlyle.
French Revolution. Thiers.
Friend of All. Green.
Frontal Attack of Infantry. Laymann.
Géographie Phisique, Historique et Militaire. Lava.
Grand Military Operations. Jomini.
Great Campaigns. King.
Grundzuge der Taktik der Drei Waffen, Infanterie, Kavallerie, und Artillerie. Brandt.
Gunnery. Hyde.
Gunpowder. Badeley, Anderson, Goodenough, Smith, and Morgan.
Gurley on Mathematical and Surveying Instruments.
Handbook for Field Service. Lefroy.
Handbook for Military Artificers, 1875. Armstrong.
Handbook of Artillery. Roberts.
Handbook of Natural Philosophy. Lardner.
Handbook of the Mechanical Arts. Burns.
Heather on Mathematical Instruments.
Heavy Artillery Tactics. Tidball.
Heerwesenund Infanteriedienst der Koniglich Preussischen Armee. Witzleben.
Histoire et Tactique des Trois Armes, et plus Particulièrement de l'Artillarie de Campagne. Favé.
History of the Dress of the British Soldier. Luard.
History of the Peninsula War. Napier.
History of the Rebellion. Tenney.
History of the War in the Peninsula and in the South of France. Napier.

Holtzapffel's Turning and Mechanical Manipulation.
How we are to Govern Ourselves. Fonblanque.
Indian and Burman Timbers. Skinner.
Infantry, Cavalry, and Artillery Tactics, United States Army.
Instructions for Armies. Lieber.
Instructions for Field Artillery.
Instructions in Military Engineering. Published by English authority.
Instructions in the Duties of Cavalry reconnoitring an Enemy, for the use of Auxiliary Cavalry.
Instruments, Mathematical, Meteorological, etc. Queen.
Jomini's Treatise on Grand Military Operations, or a Critical and Military History of the Wars of Frederick the Great. Holabird.
Journals of the Royal United Service Institution.
Judge-Advocate and Recorder's Guide. Regan.
Knight's Mechanical Dictionary.
Kriegsfeuerwerkerei Zum Gebrauch für die Königlich Preussische Artillerie. Bath.
Kriegswörterbuch. Loehr.
Law Dictionary. Bouvier.
Law of Nations. Vattel.
Législation et Administration Militaires. Guillot.
Lessons of War from the Great Masters. Soady.
Life of Napoleon. Jomini.
Life of the Duke of Marlborough. Coxe.
Manual for Engineer Troops. Duane.
Manual for Rifle Practice. Wingate.
Manual of English Artillery Exercises, 1875.
Manual of Instructions for Testing the Defective Vision of Soldiers. Longmore.
Manual of Military Law. Pipon and Collier.
Manuel complet à l'Usage des Candidats au Grade d'Officier d'Infanterie. Turlin.
Manuel d'Administration et de Complabilité à l'usage des Officiers des Compagnies ou Escadron des Corps d'Infanterie et de Cavalerie. Ruffin.
Maunder's Treasury of Knowledge.
Maxims of War. Napoleon.
Mayhew on the Horse.
Mechanic's Magazine.
Mémoire sur divers Perfectionnements Militaires. Cavalli.
Memoirs. Sherman.
Method of Horsemanship. Baucher.
Militair Conversations-Lexikon. Von der Lühe.
Military Bridges. Cullum.
Military Bridges. Haupt.
Military Carriages. Close.
Military Carriages, Treatise on. Kemmis.
Military Catechism and Handbook. Walshe.
Military Commission in Europe. McClellan.
Military Dictionary. Duane.
Military Dictionary. Scott.
Military Engineering. Mahan.
Military Gymnastics. Farrow.
Military Law and Court-Martial. Benét.
Military Law Authorities. Hough.
Military Law. Clode.
Military Miscellany. Marshall.
Military Schools and Courses of Instruction in the Science and Art of War. Barnard.
Military Sketching and Reconnaissance. Hutchison and MacGregor.
Military Telegraph during the Civil War in the U. S. Plum.
Motion of Projectiles. Owen.
Mountain Scouting. Farrow.
Mutiny Act and Articles of War.
Naval and Military Technical Dictionary of the French Language. Burns.
Naval Gunnery. Douglas.
Naval Ordnance and Gunnery. Cook.
New Bayonet Exercise. Kelton.
Operations of War, 2d and 3d editions. Hamley.
Orders and Correspondence of General Winfield Scott, Congressional Documents, etc.
Ordnance and Armor. Holley.
Ordnance and Gunnery. Benton.
Ordnance and Naval Gunnery. Simpson.
Outpost. Mahan.
Outposts. Hamley.
Pictorial Field-book of the War of 1812. Lossing.
Practical Treatise on Attack and Defense. Jebb.
Precis of Modern Tactics. Home.
Principles of Gunnery. Sladen.
Queen's Regulations, 1873.
Regulations and Instructions for Encampments (English).
Report on the Transport of Sick and Wounded by Pack Animals. Otis.
Reports of the Chief of Ordnance, U. S. Army, 1872-1884.
Revue d'Artillerie.
Revue Militaire de l'Étranger (Paris).
Rifle Exercises and Musketry Instructions.
Rifle Firing. Laidley.
Rifles and Rifle Practice. Wilcox.
Royal Artillery, History of. Duncan.
Russian Campaigns in Turkey, 1877-78. Greene.
Sandhurst Papers.
Science, La, des Personnes de Cour, d'Épée et de Robe.
Shifts and Expedients of Camp-Life. Lord and Baines.
Short Notes on Field Batteries. Browne.
Simmons on Courts-Martial.
Small's Veterinary Tablet.
Some Weapons of War. Bartlett.
Spectateur Militaire (Paris).
Steam Engine. Burns.
Strategy and Tactics. Dufour.
Studies in Tactics of Infantry. Von Scherff.
Sur la Formation des Troupes pour le Combat. Jomini.
Tableau Analytique. Jomini.
Tactical Deductions from the War of 1870-71. Boguslawski.
Tactics and Strategy. Twemlow.
Text-book for School of Musketry at Hythe.
Text-book of Gunnery. Mackinlay.
Text-book of the Construction and Manufacture of the Rifled Ordnance in the British Service. Stoney and Jones.
The Administration and Organization of the British Army, with especial Reference to Supply and Finance. Fonblanque.
The Armies of Europe. McClellan.
The Art of Travel. Galton.
The Duties of the General Staff. Von Schellendorf.
The Elements of Military Art and History. Duparcq.
The Elements of Modern Tactics. Shaw.
The Law relating to Officers in the Army. Prendergast.
The Military Laws of the United States. Callan.
Theory of War. Macdougall.
The Soldier's Pocket-book for Field Service. Wolseley.
Tomlinson's Cyclopedia of the Useful Arts and Manufactures.
Treatise on Cranes. Towne.
Treatise on Fortification. Leady.
United States Army Regulations.
United States Bridge Equipage.
United States Revised Statutes.
Voyle's Military Dictionary.
Weale's Series.
Weapons of War. Demmin.
Webster's Dictionary.
West Point; or, Information for those about to Enter the Academy. Farrow.
Wilhelm's Military Dictionary and Gazetteer.
Worcester's Dictionary.
Youatt on the Horse. Skinner.

ABBREVIATIONS OF MODERN TERMS, PHRASES AND TITLES EMPLOYED IN FARROW'S MILITARY ENCYCLOPEDIA.

A.A.S. (*Academiæ Americanæ Socius.*) Member of the American Academy.
A.B. (*Artium Baccalaureus.*) Bachelor of Arts.
A.B.C.F.M. American Board of Commissioners for Foreign Missions.
Abp. Archbishop.
A.C. (*Ante Christum.*) Before Christ.
A. D. (*Anno Domini.*) In the year of our Lord.
Æt. (*Ætatis.*) Of age; aged.
Al. Alabama.
A.M. (*Artium Magister.*) Master of Arts; (*Ante Meridiem*) Before noon; (*Anno Mundi*) In the year of the world.
An. (*Anno.*) In the year.
Apr. April.
A.R. (*Anno Regni.*) In the year of the reign.
Ark. Arkansas.
A.U.C. (*Anno Urbis Conditæ.*) In the year from the foundation of the city.
Aug. August.
Avoir. Avoirdupois.
B. Book; (*b.*) Born.
B.A. Bachelor of Arts.
Bal. Balance.
Bart. Baronet.
Bbl. Barrel.
B.C. Before Christ.
B.C.L. Bachelor of Civil Law.
B.D. Bachelor of Divinity.
Bd. Bound.
Bds. Bound in boards.
Benj. Benjamin.
Bk. Book.
B.L. Bachelor of Laws; Breech-loading.
B.L.R. Breech-loading rifled.
Bp. Bishop.
Brig.-Gen. Brigadier-General.
C., or *Cap.* (*Caput.*) Chapter.
Cal. California.
Cam., or *Camb.* Cambridge.
Caps. Capitals.
Capt. Captain.
C.B. Companion of the Bath.
C.C.P. Court of Common Pleas.
C.E. Civil Engineer.
Cent. (*Centum.*) A hundred.
C.J. Chief Justice.
C.O. Commanding officer.
Co. Company.
Col. Colonel; Colorado.
Com. Commodore.
Conn., or *Ct.* Connecticut.
Cor. Corinthian.
Cor. Sec. Corresponding Secretary.
Crim. Con. Criminal Conversation; Adultery.
Ct. Cent.
Cts. Cents.
Cwt. Hundredweight.
D., or *d.* Penny, *or* pence.
Dan. Daniel.
D.A.Q.M.G. Deputy Assistant Quartermaster-General.
D.C. District of Columbia.
D.C.L. Doctor of Civil Law.
D.D. (*Divinitatis Doctor.*) Doctor of Divinity.
Dea. Deacon.
Dec. December.
Del. Delaware.
Dep. Deputy.
Dept. Department.
Deut. Deuteronomy.
Deft., or *dft.* Defendant.
Dist. District.
Dist. Atty. District Attorney.
ditto, or *do.* The same.
D.M. Doctor of Music.
Dols. ($) Dollars.
Doz. Dozen.
Dr. Doctor; Debtor; Dram.
D.V. (*Deo Volente.*) God willing.
Dwt. Pennyweight.
E. East.
Ed. Edition; Editor.
Edw. Edward.
E.g., or *e.g.* (*exempli gratia.*) For example.
Eliz. Elizabeth.
E.N.E. East-North-East.
Eph. Ephesians.
Esq. Esquire.
et. al. (*et alii.*) And others.
etc., or *&c.* (*et cætera.*) And so forth.
et seq. (*et sequentia.*) And what follows.
Exod. Exodus.
Expl. Explanation.
Ez. Ezra.
Ezek. Ezekiel.
Fahr. Fahrenheit.
Feb. February.
F.G. Fine grain; Field-gun.
Fl., or *Flor.* Florida.
Fred. Frederic.
F.R.S. Fellow of the Royal Society.
F.S. Field-service.
Ft. Foot, *or* feet.
Fur. Furlong.
Ga. Georgia.
G.B. Great Britain.
G.C. Good conduct.
G.C.B. Grand Cross of the Bath.
Gen. General; Genesis.
Geo. George; Georgia.
Gov. Governor.
Gov.-Gen. Governor-General.
G.S. General service.
G.S.W. General service wagon.
H., or *h.* Hour.
Hab. Habakkuk.
H.B.M. His, or Her, Britannic Majesty.
H.C. House of Commons.
Heb. Hebrews.
Hhd. Hogshead.
H.L. House of Lords.
H.M. His, *or* Her, Majesty.
H.M.S. His, *or* Her, Majesty's Ship, *or* Service.
Hon. Honorable.
Hos. Hosea.
H.R. House of Representatives.
H.R.H. His, *or* Her, Royal Highness.
Hund. Hundred.
I., or *Isl.* Island.
Ib., *Ibid.* (*Ibidem.*) In the same place.
Id. (*Idem.*) The same.
i.e. (*id est.*) That is.
I.H.S. (*Jesus Hominum Salvator.*) Jesus the Saviour of men.
Ill. Illinois.
In. Inches.
Incog. (*Incognito.*) Unknown.
Ind. Indiana.
I.N.R.I. (*Jesus Nazarenus, Rex Judæorum.*) Jesus of Nazareth, King of the Jews.
Inst. Instant (the current month).
Io. Iowa.
i.q. (*idem quod.*) The same as.
Is. Isaiah.
It. Italics
J. Justice; Judge.
Jan. January.
Jas. James.
Jer. Jeremiah.
Jno. John.
Jona. Jonathan.
Jos. Joseph.
Josh. Joshua.
J.P. Justice of the Peace.
Jr., or *Jun.* Junior.
Judg. Judges.
Jul. July.
Kan. Kansas.
K.B. Knight of the Bath; King's Bench.
K.C.B. Knight Commander of the Bath.
Ken., or *Ky.* Kentucky.
K.G. Knight of the Garter.
K.G.C. Knight of the Grand Cross.
Ki. Kings.
Knt., or *Kt.* Knight.
L., or *lb.* Pound (weight).
L., *l.*, or *£.* Pound sterling.
La. Louisiana.
Lat. Latitude.
L.G. Large grain.
L.I. Long Island.
Lieut. Lieutenant.
LL.B. Bachelor of Laws.
LL.D. Doctor of Laws.
L.L.R. Line of least resistance.
L.S. Land-service.
M., or *m.* Masculine.
M.A. Master of Arts; Military Academy.
Maj. Major.
Mar. March.
Mass. Massachusetts.
Matt. Matthew.
M.C. Member of Congress.
M.D. Doctor of Medicine.
Md. Maryland.
Mdlle., or *Mlle.* Mademoiselle.
M.E. Mechanical Engineer.
Me. Maine.
Mem. Memorandum.
Messrs. Gentlemen.
Meth. Methodist.
Mich. Michigan.
Min., or *min.* Minute, or minutes.
Minn. Minnesota.
Miss. Mississippi.
M.L. Muzzle-loading.
M.L.R. Muzzle-loading rifled.
MM. Messieurs.
Mme. Madame.
Mo. Missouri; Month.
Mons. Monsieur.
Mos., or *mos.* Months.
M.P. Member of Parliament.
M.P.P. Member of Provincial Parliament.
Mr. Master, or Mister.
Mrs. Mistress, *or* Missis.
M.S. Sacred to the Memory.
MSS. Manuscripts.
Mt. Mount, *or* Mountain.
M.T. Mountain train.
Mus D. Doctor of Music.
N., or *n.* North; Noun; Neuter.
N.A. North America.
Nath. Nathaniel
N.B. New Brunswick; (*Nota bene*) Note well, *or* take notice.
N.C. North Carolina; Non-commissioned.
N.C.O. Non-commissioned Officer.
N.E. North-East; New England.
Neb. Nebraska
N.F. Newfoundland.
N.H. New Hampshire.
N.J. New Jersey.
N.L. North Latitude.
N.N.E. North North-East.
N.N.W. North-North-West.
No. (*Numero.*) Number.
Non seq. (*Non sequitur.*) It does not follow.
Nos. Numbers.
Nov. November.
N.P. Notary Public; New pattern.
N.S. Nova Scotia; The New Style (since 1752).
N.T. New Testament.
N.W. North-West.
N.Y. New York.
O. Ohio.
Ob. (*Obiit.*) Died.
Ob., or *Obdt.* Obedient.
Oct. October.
O.P. Old Pattern.
Or. Oregon.
O.S. Old Style.
O.T. Old Testament.
Oxf., or *Oxon.* (*Oxonia.*) Oxford.
Oz. Ounce, *or* ounces.
P., or *p.* Page; Pebble.

Pa., or *Penn.* Pennsylvania.
Parl. Parliament.
Pd. Paid.
P.E.I. Prince Edward Island.
Per cent. (*Per centum.*) By the hundred.
Ph.D. (*Philosophiæ Doctor.*) Doctor of Philosophy.
Phil. Philippians.
Phila. Philadelphia.
Pinx., or *Pxt.* (*Pinxit.*) Placed after the painter's name on pictures: as, "Turner *pxt.*"
Pk. Peck.
Pl. Plural.
Plff. Plaintiff.
P.M. Postmaster; Past Master; (*Post Meridiem*) Afternoon.
P.M.G. Postmaster-General.
P.O. Post-Office.
pp. Pages.
P.P.C. (*Pour Prendre Congé.*) To take leave.
Pr., or P. (*Per.*) By the.
Pres. President.
Prof. Professor.
Pro tem. (*Pro tempore.*) For the time being.
Prov. Proverbs; Province.
Prox. (*Proximo.*) Next (the next month).
P.S. (*Post Scriptum.*) Postscript.
Ps. Psalm, or Psalms.
Pt. Pint.
Pub Doc. Public Documents.
Pwt. Pennyweight.
Q., or *Qu.* Query; Question; Queen.
Q.B. Queen's Bench.
Q.C. Queen's Council.
Q.E.D. (*Quod Erot Demonstrandum.*) Which was to be demonstrated.
Q.M. Quartermaster.
Q.M.G. Quartermaster-General.
Qr. Quarter (28 pounds); Farthing; Quire.
Qt. Quart; Quantity.
Qv. (*Quod vide.*) Which see.
R. (*Rex*) King; (*Regina*) Queen.
R.A. Royal Academy, or Academician; Rear-Admiral; Right Ascension; Royal Artillery.
R.C.D. Royal Carriage Department.
R.E. Royal Engineers.
Rec. Sec. Recording Secretary.
Rev. Revelation; Reverend.
R.F.G. Rifle fine grain.
R.G.F. Royal gun factory.
R.I. Rhode Island.
R.L. Royal Laboratory.
R.L.G. Rifle large grain.
R.M.A. Royal Military Academy.
R.N. Royal Navy.
Rom. Roman; Romans.
Rom. Cath. Roman Catholic.
R.R. Railroad.
Rt. Hon. Right Honorable.
Rt. Rev. Right Reverend.
S. South; Signor; Shilling.
S.A. South America; Small arms.
S.A.A. Small-arm ammunition.
S. Afr. South Africa.
Sat. Saturday.
S.B. Smooth-bore.
S.C. South Carolina; Scrap-carriage.
Sc., or *Sculp.* (*Sculpsit.*) Placed after the engraver's name on a picture.
Sch., or *Schr.* Schooner.
Scil., or *Sc.* (*Scilicet.*) To wit; namely.
Script. Scripture.
S.E. South-East.
Sec. Secretary; Section.
Sen. Senate; Senator; Senior.
Sep., or *Sept.* September.
Serg. Sergeant.
Serv., or *Servt.* Servant.
S.J. Society of Jesus.
S.J.C. Supreme Judicial Court.
S. Lat. South Latitude.
Sld. Sailed.
Sm. Samuel.
S.M.I. (*Sa Majesté Impériale.*) His, or Her, Imperial Majesty.
S.O. Staff Officer.
Soc. Society.
Sq. Square.
Sq. ft. Square feet.
Sq. in. Square inches.
Sq. m. Square miles.
Sr. Sir, or Senior.
SS., or *ss.* (*Scilicet.*) Namely.
S.S. Sea-service; Sunday-school.
S.S.E. South-South-East.
S.S.W. South-South-West.
St. Saint; Street.
Stat. Statute.
S.T.D. (*Sacræ Theologiæ Doctor.*) Doctor of Divinity.
Sun., or *Sund.* Sunday.
Supt. Superintendent.
S.W. South-West.
Ten., or *Tenn.* Tennessee.
Tex. Texas.
Th., or *Thurs.* Thursday.
Theo. Theodore.
Tr. Translation; Transpose; Treasurer; Trustee.
Tu., or *Tues.* Tuesday.
Ult. (*Ultimo.*) Last, or Pertaining to the last month.
U.S. United States.
U.S.A. United States of America; United States Army.
U.S.M. United States Mail; United States Marine.
U.S.M.A. United States Miiltary Academy.
U.S.N. United States Navy.
U.S.V. United States Volunteers.
U.T. Utah Territory.
Va. Virginia.
V.C. Victoria Cross.
Vice-Pres. Vice-President.
Vid. (*Vide.*) See.
Vis., or *Visc.* Viscount.
Viz. (*Videlicet.*) Namely; to wit.
V.n. Verb neuter.
Voc. Vocative.
Vol. Volume.
V.P. Vice-President.
V.R. (*Victoria Regina.*) Queen Victoria.
Vs. (*Versus.*) Against.
Vt. Vermont.
W. Week; West.
Wash. Washington.
Wed. Wednesday.
W.I. West India; West Indies.
W. Lon. West Longitude.
Wm. William.
W.M. Worshipful Master.
W.N.W. West-North-West.
W.S.W. West-South-West.
Wt. Weight.
Xmas. Christmas.
Y. Year.
Yd. Yard.
Yr. Your.
Zach. Zachary.
Zech. Zechariah.
Zeph. Zephaniah.

FOREIGN WORDS AND PHRASES EMPLOYED IN FARROW'S MILITARY ENCYCLOPEDIA.

Ab ante. (L.) Before; previously.
A bas. (Fr.) Down.
Ab extra. (L.) From the outside.
Ab initio. (L.) From the beginning.
Ab origine. (L.) From the origin.
Ab ovo usque ad mala. (L.) From the egg to the apples; from first to last. Roman banquets began with eggs, and ended with apples.
Ab urbe conditâ. (L.) From the foundation of the city.
A compte. (Fr.) On account.
Ad infinitum. (L.) To infinity.
Ad interim. (L.) In the mean while.
Ad libitum. (L.) At one's pleasure.
Ad nauseam. (L.) To disgust; till disgust is excited.
Ad patres. (L.) To his fathers; *i.e.*, dead.
Ad referendum. (L.) Till further consideration.
Ad valorem. (L.) According to; upon the value.
Affaire d'amour. (Fr.) An intrigue; a love-affair.
Affaire d'honneur. (Fr.) An affair of honor; *i.e.*, a duel.
A fortiori. (L.) With stronger reason.
A gusto. (Ital.) To one's heart's content.
A la bonne heure. (Fr.) In happy time; at a good hour.
A la Française. (Fr.) In the French manner.
A la mode. (Fr.) In fashion; fashionable.
A l'Anglaise. (Fr.) In the English manner.
Al fresco. (Ital.) In the open air.
Alias. (L.) Otherwise; *e.g.*, Jones, *alias* the Count Johannes.
Alibi. (L.) Elsewhere. A legal defense by which the defendant attempts to show that he was absent at the time and from the place of the commission of the crime.
Allons. (Fr.) Come on; let us go.
Alma mater. (L.) A nourishing mother. A name frequently applied by students to their college.
A l'outrance. (Fr.) To the uttermost; the last extremity.
Alter ego. (L.) A second self.
Alumnus. (L.) A foster-child; a pupil. The graduates of American colleges are often called *alumni*.
Amende honorable. (Fr.) To make the *amende honorable* is to make a suitable apology for and confession of one's offense.
Amor patriæ. (L.) Love of country; patriotism.
Amour propre. (Fr.) Self-esteem.
Ancien régime. (Fr.) The old government; the French monarchy before the Revolution.
Anno Domini. (L.) In the year of our Lord.
Anno mundi. (L.) In the year of the world.
Annus mirabilis. (L.) The wonderful year.
Ante bellum. (L.) Before the war.
Ante meridiem. (L.) Before noon.
A posteriori. (L.) From the latter; the cause from the effect.
A priori. (L.) From the former; the effect from the cause.
A propos. (Fr.) Appositely; seasonably; in regard to.
Argumentum ad hominem. (L.) An argument to the man; *i.e.*, personal.
Audi alteram partem. (L.) Hear the other part; both sides.
Au fait. (Fr.) Skilled; accomplished; competent.
Au fond. (Fr.) To the bottom; thoroughly.
Au revoir. (Fr.) Good-by, till we meet again.
Auto da fé. (Sp.) An act of faith; *i.e.*, burning heretics.
Aux armes. (Fr.) To arms.
A votre santé. (Fr.) To your health.
Bas bleu. (Fr.) A bluestocking; a literary woman.
Beau idéal. (Fr.) Ideal beauty. The absolute beauty which exists only in the mind.
Beau monde. (Fr.) The gay world; the world of fashion.

Bel esprit. (Fr.) A fine mind; wit.
Ben trovata. (Ital.) Well found; "a happy thought."
Bête noir. (Fr.) A scarecrow; a bugbear.
Billet-doux. (Fr.) A love-letter; a "sweet" note.
Bizarre. (Fr.) Strange; eccentric; fanciful.
Blasé. (Fr.) One who has seen and enjoyed everything, and upon whom pleasure palls, is called *blasé*.
Bonâ fide. (L.) In good faith; genuine; actual.
Bon-gré, mal-gré. (Fr.) With a good or ill grace; willy-nilly.
Bonhomie. (Fr.) Simple, unaffected good-nature.
Bon-jour. (Fr.) Good-day; good-morning.
Bon-mot. Fr.) A good word, *i.e.*, a witty saying.
Cæteris paribus. (L.) Other things being equal.
Canaille. (Fr.) The rabble; the common multitude.
Carte blanche. (Fr.) Blank sheet of paper. To give a person *carte blanche* is to give him an unconditional discretion.
Casus belli. (L.) A case of war; an act which justifies war.
Cedant arma togæ. (L.) Let arms yield to the gown; *i.e.*, military to civil power.
Cela va sans dire. (Fr.) That goes without saying; follows as a matter of course and necessarily.
Chacun à son goût. (Fr.) Every man to his taste.
Châteaux en Espagne. (Fr.) Castles in Spain; air castles.
Chef d'œuvre. (Fr.) A masterpiece; an unequaled work.
Che sarà, sarà. (Ital.) What is to be, will be.
Chevalier d'industrie. (Fr.) An adventurer; one who lives by his wits.
Chronique scandaleuse. (Fr.) A record of scandals.
Cicerone. (Ital.) A person who acts as guide to sight-seers.
Comme il faut. (Fr.) Neatly; properly; rightly; in "good form."
Compagnon de voyage. (Fr.) Companion of one's travels.
Compos mentis. (L.) Sane; of sound mind.
Con amore. (Ital.) Earnestly; zealously.
Con spirito. (Ital.) In a spirited manner.
Corps Diplomatique. (Fr.) The foreign ambassadors.
Corpus delicti. (L.) The body of the offense.
Coup d'état. (Fr.) A bold stroke in politics.
Coup de grâce. (Fr.) A stroke of mercy; a final blow.
Coup de main. (Fr.) A bold, swift understanding.
Coup d'œil. (Fr.) A swift glance of the eye.
Coûte qu'il coûte. (Fr.) Let it cost what it may.
Cui bono. L.) To what (for whose) good.
Cum grano salis. (L.) With a grain of salt; not unqualifiedly.
Currente calamo. (L.) Rapidly and fluently.
Da capo. (Ital.) From the beginning.
De bonne grâce. (Fr.) Readily; with good will.
Début. (Fr.) One's first appearance in society, or on the stage.
De facto. (L.) Actual; in fact.
De gustibus non est disputandum. (L.) There is no disputing about tastes.
De jure. (L.) Rightfully; lawfully; lawful.
De mortuis nil nisi bonum. (L.) Say nothing but good of the dead.
Dénouement. (Fr.) The catastrophe of a plot.
De novo. (L.) Anew; over again; afresh.
Deo volente. (L.) If it please God.
Dernier ressort. (Fr.) The last resource.
De trop. (Fr.) In the way; too much.
Dieu et mon droit. (Fr.) God and my right.
Distingué. (Fr.) Distinguished in manner.
Distrait. (Fr.) Preoccupied; absent-minded.
Divide et impera. (L.) Divide and govern.
Dolce far niente. (Ital.) Sweet do-nothing; luxurious idleness.
Double entente. (Fr.) Double meaning; obscenity in disguise. (Often erroneously written *double entendre*.)
Douceur. (Fr.) Sweetness; compensation; a gratuity.
Dramatis personæ. (L.) The characters of a drama.
Dulce domum. (L.) Sweet home.
Dum vivimus, vivamus. (L.) While we live, let us live; enjoy life to the full.
Éclat. (Fr.) Splendor; distinction; brilliancy.
Élan. (Fr.) A spring; fire; dash; impetuosity.
Embarras de richesses. (Fr.) Embarrassment of riches; excess of anything.
Embonpoint. (Fr.) Plumpness of figure.
Empressement. (Fr.) Enthusiasm; eagerness.
En famille. (Fr.) In family; by themselves.
Enfant gâté. (Fr.) A spoiled child.
Enfant terrible. (Fr.) A terrible child; making ill-timed remarks.
En grande toilette. (Fr.) In full dress; toilet.
En masse. (Fr.) In a body.
En rapport. (Fr.) In communication.
En règle. (Fr.) As it should be; in rule.
En revanche. (Fr.) To make up for it.
En route. (Fr.) On one's way.
En suite. (Fr.) In company together.
Entente cordiale. (Fr.) A cordial understanding.
Entourage. (Fr.) Surroundings; adjuncts.
Entre nous. (Fr.) Between ourselves.
E pluribus unum. (L.) One of many. Motto of the United States.
Ergo. (L.) Therefore.
Esprit de corps. (Fr.) The spirit of the body; a feeling for the honor and interest of an organization.
Esprit fort. (Fr.) A skeptic; a freethinker.
Et cætera. (L.) And the rest; etc.
Ex cathedrâ. (L.) From the chair; with authority.
Excelsior. (L.) Higher.
Exeunt omnes. (L.) They all go out.
Ex nihilo nihil fit. (L.) From nothing, nothing comes.
Ex officio. (L.) By virtue of his office.
Ex parte. (L.) From a part; one-sided.
Ex post facto. (L) After the deed is done.
Ex tempore. (L.) Off-hand.
Facile princeps. (L.) Easily the chief.
Facilis est descensus Averni. (L.) The descent into hell is easy.
Fait accompli. (Fr.) An accomplished fact.
Faux pas. (Fr.) A false step; a mistake.
Fecit. (L.) He, or she, made. This word is put after an artist's name on a picture.
Felo de se. (L.) A felon of himself; a suicide.
Femme de chambre. (Fr.) A chambermaid.
Femme sole. (Fr.) An unmarried woman.
Festina lentè. (L.) Make haste slowly.
Fête champêtre. (Fr.) A rural party; a party in the open air.
Feuilleton. (Fr.) A small leaf. The bottoms of the pages in French newspapers are so called, being given up to light literature.
Fiat justitia, ruat cælum. (L.) Let justice be done, though the heavens fall.
Finis coronat opus. (L.) The end crowns the work.
Flagrante delicto. (L.) In the act.
Fugit hora. (L.) The hour flies.
Gamin. (Fr.) A street-urchin.
Garçon. (Fr.) A waiter.
Garde du corps. (Fr.) A body-guard.
Garde mobile. (Fr.) Troops liable for general service.
Gasconnade. (Fr.) Boasting; bragging.
Gaucherie. (Fr.) Awkwardness; clumsiness.
Gendarme. (Fr.) An armed policeman.
Genius loci. (L.) The genius of the place.
Gentilhomme. (Fr.) A gentleman; nobleman.
Genus homo. (L.) The human race.
Gloria in excelsis. (L.) Glory to God in the highest.
Gloria Patri. (L.) Glory to the Father.
Grand siècle. (Fr.) A great century.
Grossièreté. (Fr.) Grossness; rudeness.
Habeas corpus. (L.) You may have the body.
Hauteur. (Fr.) Haughtiness; loftiness.
Hic et ubique. (L.) Here and everywhere.
Hic jacet. (L.) Here lies.
Homme d'état. (Fr.) A statesman.
Honi soit qui mal y pense. (Fr.) Shame to him who evil thinks.
Horribile dictu. (L.) Horrible to say.
Hors de combat. (Fr.) Out of condition to fight.
Hôtel de ville. (Fr.) A town-hall.
Ibidem. (L.) In the same place.
Ich dien. (Ger.) I serve. (Motto of the Prince of Wales.)
Ici on parle Français. (Fr.) French spoken here.
Idem sonans. (L.) Sounding the same.
Id est. (L.) That is; i.e.
Ignis fatuus. (L.) A foolish fire; a delusion.
Ignobile vulgus. (L.) The ignoble crowd.
Ignotum per ignotius. (L.) The unknown by something more unknown.
Imprimis. (L.) In the first place.
In articulo mortis. (L.) At the point of death.
Index expurgatorius. (L.) A purging index; a list of works prohibited to be read.
In embryo. (L.) In the rudiments.
In esse. (L.) Actual; in existence.
In extremis. (L.) At the point of death.
In flagrante delicto. (L.) In the very act.
Infra dignitatem. (L.) Beneath one's dignity.
In futuro. (L.) In the future.
In hoc signo vinces. (L.) In this sign thou shalt conquer.
In loco. (L.) In place; on the spot.
In medias res. (L.) In the middle of a subject.
In pace. (L.) In peace.
In perpetuum. (L.) Forever.
In propriâ personâ. (L.) In one's own person.
In re. (L.) In the thing; in the matter of.
In rem. (L.) Against the thing.
In sæculâ sæculorum. (L.) For ages of ages.
Instanter. (L.) Instantly.
In statu quo. (L.) In the state in which it was.
Inter alia. (L.) Among other things.
Inter nos. (L.) Between ourselves.
Inter se. (L.) Among themselves.
In toto. (L.) Entirely; wholly.
In transitu. (L.) In the passage; on the way.
In vino veritas. (L.) In wine there is truth.
Ipse dixit. (L.) He said it himself.
Ipso facto. (L.) By the fact itself.
Je ne sais quoi. (Fr.) I know not what.
Jeu de mots. (Fr.) A play upon words.
Jour de fête. (Fr.) A saint's day; a festival.
Jubilate Deo. (L.) Be joyful to God.
Jupiter tonans. (L.) Jupiter the thunderer.
Jure divino. (L.) By divine law.
Jure humano. (L.) By human law.
Jus civile. (L.) The civil law.
Jus gentium. (L.) The law of nations.
Juste milieu. (Fr.) The golden mean.
Labor omnia vincit. (L.) Labor conquers all things.
Laissez faire. (Fr.) Let things alone.
Lapsus linguæ. (L.) A slip of the tongue.
Lares et penates. (L.) The household gods.
Laus Deo. (L.) Praise be to God.
L'avenir. (Fr.) The future.
Le beau monde. (Fr.) The world of fashion.
Lèse majesté. (Fr.) High treason.
Lex loci. (L.) The law of the place.
Lex scripta. (L.) The written law.
Lex talionis. (L.) The law of retaliation.
Literatim. (L.) Letter for letter.
Littérateur. (Fr.) A literary man.
Locus sigilli. (L.) The place of the seal.
Ma chère. (Fr.) My dear.
Ma foi. (Fr.) My faith; upon my faith.
Magnum bonum. (L.) A great good.
Maison de ville. (Fr.) The town-house.
Maître d'hôtel. (Fr.) A house-steward.
Major domo. (Ital.) A chief steward.
Maladie du pays. (Fr.) Home-sickness.
Matériel. (F.) Opposed to personnel.
Mater familias. (L.) The mother of a family.

Mauvaise honte. (Fr.) Bashfulness.
Maximum. (L.) The greatest possible.
Me judice. (L.) In my judgment.
Memento mori (L.) Remember death.
Memorabilia. (L.) Things deserving to be remembered.
Mens sana in corpore sano. (L.) A sound mind in a sound body.
Meum et tuum. (L.) Mine and thine.
Mirabile dictu. (L.) Wonderful to tell.
Mise en scène. (Fr.) Putting on the stage.
Modus operandi. (L.) The method of operating
Mon ami. (Fr.) My friend.
Mot d'ordre. (Fr.) The password; countersign.
Multum in parvo. (L.) Much in little.
Nemine contradicente. (L.) No one contradicting.
Ne plus ultra. (L.) Nothing more beyond; the utmost.
Nil admirari. (L.) To wonder at nothing.
Nil desperandum. (L.) We must not despair.
Ni l'un ni l'autre. (Fr.) Neither the one nor the other.
N'importe. (Fr.) It does not matter.
Nisi prius. (L.) Unless before.
Noblesse oblige. (Fr.) Nobility obliges; noble must act nobly.
Nolens volens. (L.) Willy-nilly.
Noli me tangere. (L.) Don't touch me; hands off.
Nolle prosequi. (L.) To abandon prosecution.
Nom de guerre. (Fr.) A war-name.
Nom de plume. (Fr.) Pen-name; name assumed by an author.
Non compos mentis. (L.) Not in one's right mind.
Non est inventus. (L.) He has not been found.
Non multa, sed multum. (L.) Not many things, but much.
Nota bene. (L.) Mark well.
Nous avons changé tout cela. (Fr.) We have changed all that.
Nous verrons. (Fr.) We shall see.
Odium theologicum. (L.) Theological hatred.
Olla podrida. (Sp) A mixture.
Omnia vincit amor. (L.) Love conquers all things.
On dit. (Fr.) They say; people say.
Onus probandi. (L.) The burden of proof.
Oro pro nobis. (L.) Pray for us.
O tempora! O mores! (L.) Oh, the times! Oh, the manners!
Otium cum dignitate. (L.) Ease with dignity.
Outré. (Fr.) Extravagant; extreme.
Par excellence. (Fr.) By way of eminence; in the highest degree.
Par hasard. (Fr.) By chance.
Pari passu. (L.) With equal step.
Parvenu. (Fr.) An upstart; a rich snob.
Pater familias. (L.) The father of a family.
Pater patriæ. (L.) The father of his country.
Pax vobiscum. (L.) Peace be with you.
Peccavi. (L.) I have sinned.
Pendente lite. (L.) While the suit is pending.
Per annum. (L.) By the year.
Per capita. (L.) By the head; on each person.
Per contra. (L.) On the other hand.
Per diem. (L.) By the day; every day.
Per se. (L.) By itself.
Personnel. (Fr.) The staff; persons in any service.
Petitio principii. (L.) Begging the question.
Petite. (Fr.) Small; little.
Pièce de résistance. (Fr.) A joint of meat.
Pinxit. (L.) He, *or* she, painted it.
Pis aller. (Fr.) A last expedient.
Plebs. (L.) The common people.
Poeta nascitur, non fit. (L.) A poet is born, not made.
Point d'appui. (Fr.) Point of support.
Posse comitatus. (L.) The power of the country; the force that may be summoned by the Sheriff.
Poste restante. (Fr.) To be left till called for.
Post meridiem. (L.) Afternoon.
Post mortem. (L.) After death.
Post obitum. (L.) After death.
Pourparler. (Fr.) A consultation.
Pour prendre congé. (Fr.) To take leave.
Précieuse. (Fr.) A bluestocking; a conceited woman.
Preux chevalier. (Fr.) A gallant gentleman.
Prima donna. (Ital.) The first lady; the principal female singer in an Italian opera.
Primâ facie. (L.) On the first face; at first sight.
Primus inter pares. (L.) First among his peers.
Pro bono publico. (L.) For the public good.
Procès verbal. (Fr.) Verbal process; the taking of testimony in writing.
Pro et con. (L.) For and against.
Pro formâ. (L.) For the sake of form.
Pro patriâ. (L.) For one's country.
Pro tempore. (L.) For the time.
Punica fides. (L.) Punic faith; *i.e.*, treachery.
Quantum sufficit. (L.) As much as is sufficient.
Quelque chose. (Fr.) As if.
Quid nunc? (L.) What now? A gossip.
Quid pro quo. (L.) An equivalent.
Qui vive. (Fr.) Who goes there?
Quod erat demonstrandum. (L.) Which was to be demonstrated.
Quondam. (L.) At one time; once.
Rara avis. (L.) A rare bird.
Rechauffé. (Fr.) Warmed over; stale.
Recherché. (Fr.) Choice; elegant.
Redacteur. (Fr.) An editor.
Redivivus. (L.) Restored to life.
Reductio ad absurdum. (L.) Reduction to an absurdity.
Rentes. (Fr.) Public funds; national securities.
Requiescat in pace. (L.) May he, *or* she, rest in peace.
Res gestæ. (L.) Things done.
Resurgam. (L.) I shall rise again.
Revenons à nos moutons. (Fr.) Let us return to our sheep; come back to the subject.
Robe de chambre. (Fr.) A dressing-gown.
Roué. (Fr.) A rake.
Rouge et noir. (Fr.) Red and black (a game).
Sanctum sanctorum. (L.) The holy of holies.
Sang froid. (Fr.) Cold blood; self-possession.
Sans culottes. (Fr.) Without breeches; red republicans.
Sartor resartus (L.) The tailor patched.
Sauve qui peut. (Fr.) Save himself who can.
Savoir-faire. (Fr.) Knowing how to do things.
Savoir-vivre. (Fr.) Knowledge of the world.
Semper idem. (L.) Always the same.
Semper paratus. (L.) Always prepared.
Sequitur. (L.) It follows.
Seriatim. (L.) In order.
Sic itur ad astra. (L.) Thus men go to the stars.
Sic semper tyrannis. (L.) Thus always with tyrants. The motto of Virginia.
Sic transit gloria mundi. (L.) So passes the glory of the world.
Similia similibus curantur. (L.) Like is cured by like.
Sine die. (L.) Without a day.
Sine qua non. (L.) Without which, not; an indispensable condition.
Soi disant. (Fr.) Self-styled.
Spirituel. (Fr.) Witty.
Status quo. (L.) The state in which; the former state.
Stet. (L.) Let it stand.
Suaviter in modo, fortiter in re. (L.) Gently in manner, bravely in action.
Sub rosâ. (L.) Under the rose; secretly.
Sui generis. (L.) Of its own kind.
Summum bonum. (L.) The supreme good.
Tableau vivant. (Fr.) A living picture.
Table d'hôte. (Fr.) A public ordinary; dinner at a fixed price.
Tabula rasa. (L.) A smooth tablet; a blank.
Tant mieux. (Fr.) So much the better.
Tant pis. (Fr.) So much the worse.
Te Deum laudamus. (L.) Thee, God, we praise.
Tempora mutantur, et nos mutamur in illis. (L.) Times change, and we change with them.
Tempus fugit. (L.) Time flies.
Terra firma. (L.) Solid earth.
Terra incognita. (L.) An unknown country.
Tête-à-tête. (Fr.) Head to head; in private conversation.
Tiers état. (Fr.) The third estate; *i.e.*, the commons.
Totidem verbis. (L.) In just so many words.
Tour de force. (Fr.) A turn of strength.
Tout ensemble. (Fr.) The whole taken together.
Tout le monde. (Fr.) Everybody.
Trottoir. (Fr.) The pavement.
Tu quoque, Brute! (L.) Thou, too, Brutus.
Ubi libertas, ibi patria. (L.) Where liberty is, there is my country.
Ubi supra. (L.) As mentioned above.
Ultima Thule. (L.) Uttermost Thule; the end of the earth.
Usque ad nauseam. (L.) Till it was, *or* is, absolutely sickening.
Utile dulci. (L.) The useful with the sweet.
Ut infra. (L.) As below.
Ut supra. (L.) As above.
Vade mecum. (L.) Go with me; a companion.
Væ victis. (L.) Woe to the vanquished.
Vale. (L.) Farewell.
Valet de chambre. (Fr.) A servant.
Veni, vide, vici. (L.) I came, I saw, I conquered.
Verbatim et literatim. (L.) Word for word; letter for letter.
Verbum sat sapienti. (L.) A word to the wise is sufficient.
Viâ. (L.) By way of.
Vide. (L.) See.
Videlicet. (L.) Namely.
Vinculum matrimonii. (L.) The bond of matrimony.
Vis à vis. (Fr.) Face to face.
Vis inertiæ. (L.) The force of inactivity.
Vis viva. (L.) Living force.
Vivâ voce. (L.) By the living voice.
Vive la bagatelle. (Fr.) Success to trifles.
Vive la Reine. (Fr.) Long live the Queen.
Vive l'Empereur. (Fr.) Long live the Emperor.
Vive le Roi. (Fr.) Long live the King.
Voilà. (Fr.) See there; behold.
Vox, et præterea nihil. (L.) A voice, and nothing more.
Vox populi, vox Dei. (L.) The voice of the people is the voice of God.

INDEX OF MATTERS NOT HAVING SPECIAL ARTICLES.

At the close of Volume III. will be found an Index of Subjects not having Special Articles. It has not been thought necessary to repeat in this Index the titles of the many thousand articles composing the body of the work. A person consulting the Encyclopedia is supposed, in the first instance, to look for the subject he is in quest of in its proper alphabetical place. If it is not to be found there, or by a *cross-reference*, by turning to the Index he is likely to get a reference to it under another name, or as coming in for notice in connection with some other subject. It frequently happens that subjects, having articles of their own, are further noticed under other heads; and where it seemed of importance, a reference is given in the Index to this additional information. The title of the article referred to is printed in *italics;* and when the article is of considerable length, the page is given in which the information is to be found.

CONTINUED REVISION.

The process of revising Farrow's Military Encyclopedia is constantly carried on, thus keeping up the information to the latest possible date. These revisions and additions will be supplied every few years in the shape of Supplements. A few blank pages are inserted at the close of each volume for the purpose of noting the reference to the various articles in the Supplements, which would naturally find alphabetical arrangement in the respective volumes.

LIST OF MAPS AND FULL-PAGE ILLUSTRATIONS IN VOLUME I.

ABACA.—The fibre of a species of plantain or banana, *Musa Troglodytarum*, a native of the Philippine Isles, where it is extensively cultivated. The leaf-stalks are split into long stripes, and the fibrous part is then separated from the fleshy pulp. A laborer can in this way produce daily 50 lbs. of hemp. Before 1825 the quantity produced was insignificant, but now it amounts to nearly 31,000 tons annually. In Manilla there is a steam rope-work for making ropes of it for naval and military purposes. They are durable, but not very flexible. The fibre of a number of species of *Musa* is used in tropical countries.

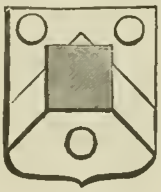
ABAISSE.—A term used in Heraldry. When the fesse or any other armorial figure is depressed, or situated below the centre of the shield, it is said to be *abaissé*. *Adossé* (back to back), *affronté* or *confronté* (facing or fronting one another), *aiguissé* (sharpened at the point), *ailé* (winged), are other heraldic terms borrowed, like *abaissé*, from the French, and used by English heralds in senses not differing essentially from their ordinary significations in that language. See *Heraldry*.

ABAMURUS.—A buttress, or second wall, built to strengthen another. These are frequently employed in fortifications.

ABANDON.—This term in a military sense signifies to retire suddenly from a place, fortified or otherwise, thus leaving it and the inhabitants to the mercy of the enemy. Abandoning any fort, post, guard, arms, ammunition, or colors without good cause is punishable as provided in the 42d Article of War. The term abandon is also used in the relinquishment of a military post, district, or station, or the breaking up of a military establishment.

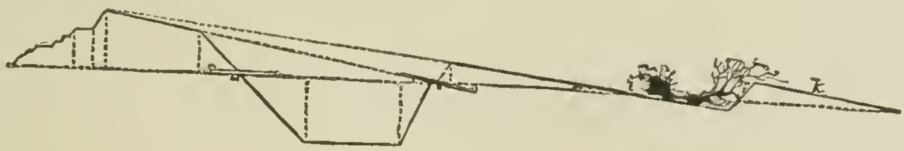
ABASE.—An old word signifying to lower a flag. *Abaisser* is in use in the French Marine, and both are probably derived from the still older *abeigh*, to cast down, to humble. In Heraldry, *abased* is used of certain armorial bearings, when turned downward toward the point of the shield. See *Heraldry*.

ABATEMENT.—In Heraldry, a mark placed over a portion of the paternal coat-of-arms of a family, significative of some base or ungentleman-like act on the part of the bearer. The coat is then said to be abated, or lowered in dignity. Guillim gives nine such marks, all of which are of either one or the other of the two disgraceful colors, tenné (tawny) and sanguine. Such are the delf tenné, assigned to him who revokes his challenge; the escutcheon reversed sanguine, proper to him who offends the chastity of virgin, wife, or widow, or flies from his Sovereign's banner; the point-dexter tenné, due to him who overmuch boasteth himself of his martial acts; and the like. Marks of abatement are generally repudiated by the best heraldic authorities. Menestrier calls them *sottises anglaises*, and Montagu is of opinion that we shall seek in vain for a more appropriate designation. Abatements are carefully to be distinguished from such subtractive alterations in coats-of-arms as signify juniority of birth, or removal from the principal house or senior branch of the family. These are commonly called marks of cadency, distinctions, differences, or brisures. The latter term is generally applied to marks of bastardy, which might with less impropriety be classed with abatements. See *Heraldry*.



Abatement.

ABATIS—ABATTIS.—An accessory means of defence formed by cutting off the smaller branches of trees felled in the direction from which the enemy may be expected. It is readily seen in the drawing how an abatis placed at *i*, will impede the approach of the enemy advancing over the glacis slope *k*, and expose his front to a galling fire from the principal guns of the work. The ends of the larger branches are sharpened, and the butts of the limbs or trees fastened by crochet-picket, or by imbedding in the earth, so that they cannot be easily removed. In redoubts or intrenchments they are usually fixed in an upright position against the counterscarp, or at the foot of the glacis, the plane of which is broken so as



Abatis.

to conceal the abatis from the view of the enemy, and to guard against obstructing the musketry-fire from the parapet in their rear. Abatis are also an excellent means of blocking up a road, when trees grow on either side. If branches are properly placed, and intertwined one within another, their disengagement is extremely difficult. An abatis will always be found a very useful and effective auxiliary to the defence of houses or isolated posts, if judiciously placed within range of musketry. When close in front of the windows on the ground-floor, or used as a cover to the entrance-door, it will be extremely difficult for the enemy to force his way into the building. It is very readily seen how a profile may be much strengthened by planting a row of palisades in the ditch, or even by driving stakes into it, and sharpening them, or making a perpendicular abatis, by planting brushwood upright in the bottom, with the ends sharpened. An expeditious way also of adding to the difficulties of an assault is seen where common hurdles or gates, rails or brushwood, laid on the ground soon after commencing the work, with their extremities buried under the parapet, may be made use of; the earth underneath them, not shown in the figure, should be cut away when the ditch has been sunk to its full depth. See *Accessory Means of Defence*.

ABDUCTION.—The diminishing the front of a line or column by breaking off a division, sub-division, or files, in order to avoid some obstacle.

ABET.—To encourage by aid or countenance; formerly used in a good, but now chiefly in a bad sense. It is a grave crime to aid or abet in mutiny or sedition, or excite resistance against lawful orders. Any officer or soldier who, being present at any mutiny or sedition, does not use his utmost endeavor to suppress the same, or, having knowledge of any intended mutiny or sedition, does not, without delay, give information thereof to his commanding officer, shall suffer death, or such other punishment as a Court-Martial may direct.

ABLE-BODIED.—A term, in a military sense, applying to one who is physically competent as a soldier for all duty.

ABLECTI.—An ancient military term applied to a select body of men taken from the *Extraordinarii* of the Roman army to serve as a body-guard to the Commanding General or the Consul. The guard consisted of forty mounted and one hundred and sixty dismounted men.

ABOLLA.—A military robe of thick woollen stuff (lined or doubled) worn by the ancient Greeks and Romans.

ABOMINATION OF DESOLATION.—The Roman standard which was set up in the Temple of Jerusalem, to which the soldiery offered sacrifices as to an idol.

ABOUT.—A technical word to express the movement by which a body of troops or artillery-carriages changes front.

ABRADANT.—A material, generally in powder, used in the armory for grinding. The term includes emery, sand, glass, and many other materials. Laps, glazers, rifles, paper, etc., are armed with abradants.

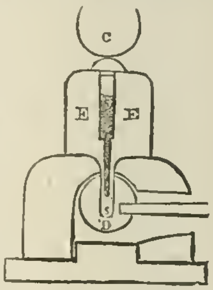
ABRI.—A French term signifying shelter, cover, concealment; arm-sheds in a camp secure from rain, dust, etc.; place of security from the effect of shot, shells, or attack.

ABSENCE.—Every officer commanding a regiment or an independent troop, battery, or company, not in the field, may, when actually quartered with such command, grant furloughs to the enlisted men, in such numbers and for such time as he shall deem consistent with the good of the service. Every officer commanding a regiment, or an independent troop, battery, or company, in the field, may grant furloughs not exceeding thirty days at one time, to five per centum of the enlisted men, for good conduct in the line of duty, but subject to the approval of the commander of the forces of which said enlisted men form a part. Every company officer of a regiment, commanding any troop, battery, or company not in the field, or commanding in any garrison, fort, post, or barrack, may, in the absence of his field-officer, grant furloughs to the enlisted men, for a time not exceeding twenty days in six months, and not to more than two persons to be absent at the same time.

Any soldier who absents himself from his troop, battery, company, or detachment, without leave from his commanding officer, shall be punished as a Court-Martial may direct.

Any officer or soldier who fails, except when prevented by sickness or other necessity, to repair, at the fixed time, to the place of parade, exercise, or other rendezvous appointed by his commanding officer, or goes from the same, without leave from his commanding officer, before he is dismissed or relieved, shall be punished as a Court-Martial may direct.

ABSOLUTE FORCE OF GUNPOWDER.—The absolute force of gunpowder is measured by the pressure which it exerts when it exactly fills the space in which it is fired. Various experiments have been made to determine mechanically the absolute expansive force of fired gunpowder, but with widely different results. Robins estimated it at 1000 atmospheres, Hutton at 1800, D'Antoni from 1400 to 1900, and Rumford carried it as high as 100,000 atmospheres. These discrepancies arise, in a great measure, from the very great difference which exists between the expansive force of the gases in the different moments of combustion, and from a want of coincidence in the observations.



The apparatus used by Rumford to determine this point consisted, essentially, of a small eprouvette, E, capable of holding exactly 25 grains of powder. The orifice was closed with a heavy weight, and the powder was fired by heating the stem of the eprouvette, S, with a red-hot cannon-ball, B. For the first trial he filled the eprouvette with 25 grains of the best quality of dry powder, and rested upon the cover the knob, C, of a 24-pdr. gun, whose weight was 8081 lbs. Notwithstanding its great strength, the eprouvette was burst at the first fire into two pieces, and the 24-pdr. was raised. Rumford endeavored to show from the weight thus raised that the pressure of the gases on the sides of the eprouvette was greater than 10,000 atmospheres. He further attempted to show, that as the tenacity of good iron is equal to 4231 times the pressure of the atmosphere on the same surface, and as the surface of rupture was 13 times that of the bore, the force necessary to produce the rupture of the eprouvette must have been 13 × 4231, or 55,003 atmospheres.

There are circumstances attending this experiment which should be taken into account, and which will very materially diminish this result. They are, the diminution of the tenacity of the iron, due to heating the eprouvette to produce explosion, and the incorrect method by which Rumford estimated the strength of a hollow cylinder subjected to a strain of expansion.

Experiments were continued with a similar apparatus to determine the relation between the density and the expansive force of fired gunpowder. The capacity of the eprouvette was nearly 25 grains. It was fired with various charges from 1 up to 18 grains; and the expansive force of each discharge was determined by the smallest weight necessary to close the orifice against the escape of the gas. With the results of 85 trials a table was formed, from which a curve was constructed which expresses the relation between the density and expansive force of fired gunpowder, from 1 to 15 grains. By analogy and calculation, this curve was continued up to a charge of 24 grains; and for the density corresponding to this charge the pressure was found to be 29,178 atmospheres.

This pressure is much greater than that developed in the explosion of projectiles and mines, owing to the low temperature of the surrounding surfaces and the large amount of heat which they absorb. It is the same with cannon, for the most rapid firing does not raise the temperature of the bore above 210° Fahr., which is much below that of the eprouvette. Besides, the powder does not completely fill the space in rear of the ball; and, as powder burns progressively, this space is enlarged before the gases are completely developed, and consequently their density is diminished. There is also a loss of force by the escape of the gases through the windage and vent.

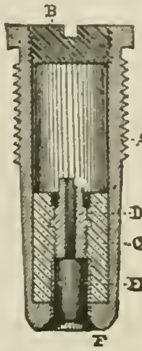
The following equation expresses the relation found to exist between the density and expansive force of charges of gunpowder, from 1 to 15 grains, fired in an eprouvette the capacity of which was 25 grains—or in other words, for charges in which the densities vary from .04 to .6: $p = 1.841(905d)^{1-0.362d}$; in which p represents the pressure in atmospheres, and d the density of the inflamed products. It will be seen from this equation that the pressure increases more rapidly than the density, since the exponent of the density is greater than unity. The density of the gases is equal to the weight of the powder burned divided by the space occupied by the gases. By substituting this in the equation, we can determine the pressure exerted at any given instant of the combustion. Although this relation is deduced for a particular kind of powder, it may be used for all service-powders and service-charges without serious error, since the actual amount of gaseous products is nearly the same for all, and the densities of the highest service-charges never exceed 0.6.

The accuracy of Rumford's formula has been lately verified by a series of experiments made by Captain Rodman. The apparatus used by this officer consisted of a very thick cast-iron shell, to which was attached an indenting piston for determining the pressure on the inner surface, or powder-cavity of the shell. The following table shows the pressures calculated by the formula and the pressures obtained by the experiments, for three different densities:

Density.	Pressure by Rumford's Formula.	Pressure by Rodman's Experiments.
$d = \frac{1}{20}$	1,290 lbs.	1,066 lbs.
$d = \frac{1}{10}$	2,900 "	2,525 "
$d = \frac{1}{2}$	3,700 "	3,220 "

The lesser pressure obtained by Rodman's experiments may be in a great measure explained by the facts that the shell was not heated, but fired with a friction-tube, and that the gas was allowed to escape through the vent. Further experiments were made which show that so long as the volume of the charge bears the same proportion to the space in which it is fired, the pressure on the unit of surface remains the same, no matter what may be the amount of the charge. This follows also from Rumford's formula, since the value of p is not affected so long as d remains the same. See *Explosion* and *Gunpowder*.

ABSTERDAM PERCUSSION-FUSE.—This fuse consists of a metal fuse-stock, A, closed at the front end by a screw-cap, B; a movable plunger, C, cast around a cone-piece, D; and a hollow tin cylinder, E. The tin cylinder, E, at the base of the plunger is cut longitudinally, so that when opened out into the recess, F, at the base of the fuse-stock, the plunger is held in place securely until the impact of the shell. The shock of discharge straightens out the tin, freeing the plunger, which moves forward to the cap, B, exploding the musket-cap on the cone-piece that ignites the bursting-charge. See *Fuse*.



ABSTERDAM PROJECTILE.—A projectile cast in a single piece and having an expanding ring of brass which projects three-eighths of an inch beyond the base of the projectile. See *Projectile*.

ABSTRACT.—A sheet of a prescribed form to accompany Returns, so prepared as to consolidate the contents of numerous Vouchers. The following is one form used by Quartermasters:

Abstract of Transfers of Funds made to officers on account of the Quartermaster's Department by ——— ———, ——— Quartermaster ———, U. S. Army, during the month of ———, 188—.

Date of Transfer.	No. of voucher.	To whom transferred.	Regular supplies.		Incidental expenses.				Barracks and quarters.		Transportation of the Army.		Clothing and equipage.								Total.	
			Dolls.	Cts.	Dolls.	Cts.	Dolls.	Cts.	Dolls.	Cts.	Dolls.	Cts.	Dolls.	Cts.	Dolls.	Cts.	Dolls.	Cts.	Dolls.	Cts.	Dolls.	Cts.
		Total..																				

I certify that the above abstract is correct.

——— *Quartermaster* ———

(Signed in duplicate.)

One copy of an Abstract is retained by the officer who makes the transfers, and the other is sent to the Chief of the Bureau with the Account-Current. See *Accounts-Current*.

ABUSES AND DISORDERS.—Every Commanding Officer is required to keep good order, and, to the utmost of his power, redress all abuses and disorders which may be committed by any officer or soldier of his command. If, upon complaint made to him of officers or soldiers beating, or otherwise ill-treating, any person, of disturbing fairs or markets, or of committing any kinds of riots, to the disquieting of the citizens of the United States, etc., the said Commander shall refuse or omit to see justice done to the offender or offenders, and reparation made to the party or parties injured, as far as part of the offender's pay shall enable him or them, he shall, upon proof thereof, be cashiered, or otherwise punished, as a General Court-Martial shall direct.

ABUTMENT.—The block at the rear of the barrel of a fire-arm (especially a breech-loader), which receives the rearward force of the charge in firing. It has the function of the *breech-plug* or *breech-pin* in the muzzle-loading fire-arm. A similar term is applied to the corresponding portion in breech-loading cannon. The variations in the arrangement are numerous, and the different devices form the subjects of many patents in the United States and foreign countries.

ACADEMIC BOARD.—The Academic Staff of the United States Military Academy. By law, the Academic Board consist of the Superintendent and the

Heads of the several departments of instruction. A majority of the Board constitutes a quorum. Dissenting members of the Board may present their views in a report which is entered on the record and transmitted to the War Department. The Board recommend for the approval of the War Department the text-books best suited for each department of instruction; examine Cadets, and decide on their merits, grant diplomas, and recommend for promotion; and report to the War Department on the system of studies and instruction, proposing any improvements therein that experience may have suggested. The deliberations and discussions of the Board are confidential, and no member nor the Secretary shall disclose the decision of the Board before the same shall be announced by proper authority, nor shall any member nor the Secretary discover or disclose the vote or opinion of any member. At the annual examination in June, the Academic Board examine, arrange in order of merit, and determine the proficiency of the Cadets of the First Class in all the studies prescribed for that class. For the purpose of examining the Cadets of the other classes, the Superintendent may, at his discretion, divide the Academic Board into Committees, each to consist of not less than three members of the Board, each Committee to examine, arrange in order of merit, and determine the proficiency of the Cadets in such branches of study as the Superintendent shall direct. The Superintendent may, at his discretion, be a member of either Committee, and preside therein; otherwise, the senior member of the Academic Board present shall preside. Each member of the Academic Board keeps careful notes of the examination, to enable him to give full and ample information, when required, of the performance of every one examined. To insure accurate classification and the ascertainment of cases of deficiency, every Instructor in charge of a section, just before its examination, carefully prepares and submits to the Examining Committee a list of such section, arranged in the order of merit as suggested by the marks during the term, and the impression which the daily recitations have left upon his mind, noting every case of doubtful proficiency. The Committees report to the Academic Board the results of their examinations of the several classes, upon which report the Board take such action as they may think proper. The senior Assistant in the branch of study under examination is a member of the Academic Board, or of the Committee, for all the purposes above mentioned; and the Instructor of the section under examination is a member of the Academic Board, or of the Committee, as the case may be, for the purpose of examining and arranging it in order of merit. The record of each Committee is kept by an officer detailed for that purpose, and is delivered by him, after the approval of the presiding officer, to the Secretary of the Academic Board,. for preservation among the records of the Academy; and no member of a Committee, nor its Secretary, shall disclose the decision of the Committee before the same shall be announced by proper authority. The Academic Board decide the question of proficiency of a Cadet by vote taken by ayes and nays (*viva voce* or by ballot, as the Board may decide). At the close of each examination the Academic Board report to the War Department the names of all Cadets who are deficient in studies or discipline, to be discharged, unless otherwise recommended by the Academic Board. The Superintendent may, at any other time, bring any Cadet before the Board to be examined, and reported in like manner, if found hopelessly deficient. No Cadet is promoted until he has completed the entire course of studies at the Academy and received a diploma from the Academic Board. In the promotion of Cadets the rank of each corresponds with his standing on the roll of general merit established by the Academic Board. No Cadet resigning his warrant, or otherwise separated from the Academy before the completion of his studies, shall receive an appointment in the Army until after the promotion of the class to which he belonged, unless on the recommendation of the Academic Board; nor then, if such appointment interferes with the rank of any Cadet of that class. The Medical Officers, convened annually at West Point, in the month of June, to examine into the physical qualifications of the candidates for admission into the Military Academy, are associated with the Superintendent of the Academy and the Commandant of Cadets; and these Officers constitute a Board for the purpose of examining into the physical qualifications of the members of the graduating class, and no member of that class can be commissioned in the Army, or attached as a supernumerary thereto, who, in the opinion of the Board, does not possess the requisite physical ability to serve his country in the arduous and laborious station of a Military Officer. See *United States Military Academy.*

ACANZI.—In military history, the name of the Turkish light-horse who formed the vanguard of the Sultan's army.

ACCELERATED MOTION.—Motion in which the velocity is continually increasing. When the increments of velocity are equal in equal times, the motion is said to be *uniformly* accelerated. The best example of such a motion is that of a falling body. It is found that near the earth's surface a body descending from a state of rest falls $16\frac{1}{12}$ ft. in the first second. Now a little consideration will show that at the end of the first second it is moving at the rate of $32\frac{1}{6}$ ft. per second. For since the velocity was nothing at first and increased uniformly, $16\frac{1}{12}$ ft. must have been the *mean* velocity—i.e., the velocity at the middle of the time; and therefore the velocity at the end must be double, or $32\frac{1}{6}$ ft.: $32\frac{1}{6}$ ft. is thus the measure of the accelerative force of gravity. At the end of the second and third seconds the velocity is found to be doubled, trebled, etc., or $64\frac{1}{3}$, $96\frac{1}{2}$ ft. See *Falling Bodies.*

ACCELERATING FORCE.—Force considered only with reference to velocity generated and not with reference to the mass moved. Accelerating force, if uniform, is measured by the velocity generated in a unit of time; if variable, by the velocity which would be generated in a unit of time if the force were continued constant during that unit. The best example of such uniform motion is that of a falling body.

ACCELERATING GUN.—A gun having additional charge-chambers and a muzzle covering, with the necessary means of exhausting the air, whereby the atmospheric resistance is removed from the front of the projectile while passing along the bore. As soon as the gun has been fired and the ball has passed the chamber, the fire in the bore ignites the charges in the additional charge-chambers, thereby giving the ball additional force. The average penetration with this gun in laminated armor composed of $\frac{1}{4}$-in. boiler-plates is $4\frac{7}{16}$ in.; and $4\frac{1}{4}$ in. in solid iron, using a $6\frac{1}{4}$-oz. steel bolt 8 in. long and $\frac{1}{2}$ in. diameter, with a charge of $4\frac{1}{8}$ oz. powder. See *Multi-charge Gun.*

ACCELEROGRAPHS.—The principle has long since been made known on which the apparatus called "accelerographs" are constructed, which the Marine Artillery Service has adopted, according to the invention of Mr. Marcel Deprez, and which are designed for measuring the succession of pressures developed in a given point of a powder-chamber by the combustion of a charge of powder either enclosed in a vessel or placed in the bore of a gun and acting on the projectile. The first apparatus which were established on this principle were experimented on in 1873, in the workshops of Mr. Bianchi, of Paris, for the study of combustion in a closed vessel; afterwards, in 1874, on the proving-ground of the Nevers foundry, for the study of combustion in guns. Since that time various improvements have been successively made in the mode of construction and in the manner of employment of these apparatus.

The accelerographs thus modified were employed several years ago, in numerous experiments, both at the laboratory of the central depot for powder and saltpetre, courteously placed at the disposal of the marine by the engineers of that service, and at the proving-ground of the Sevran-Livry powder-works with the double advantage of proving the material and the powder fabricated on the account of the department of the marine. In these trials these apparatus proved convenient for handling and of practical employment, and they furnished some valuable observations on the law of combustion of powder-charges, and on that of the development of the pressures resulting therefrom both in close vessels and in guns of various calibres. Also, by a slight modification of the accelerograph, employed for measuring the pressures developed in the firing of guns, this apparatus can be utilized for determining simultaneously the law of the pressure developed in the bore and the

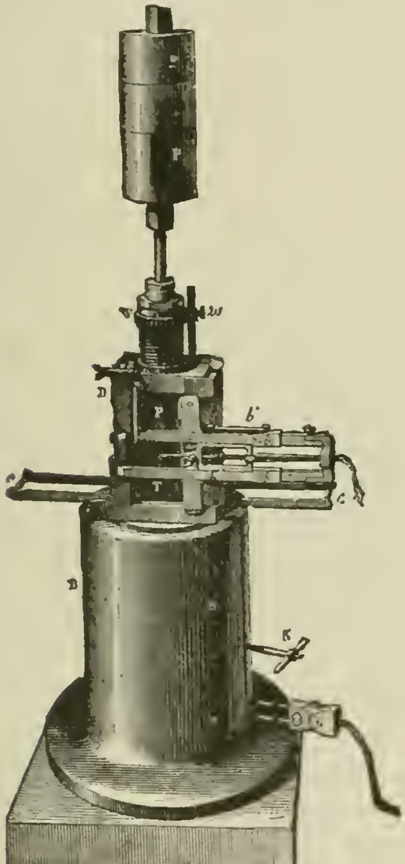


Fig. 1.

law of the recoil of the gun. The accelerographs in question were of the types called slide-accelerographs, in which the law of the movement of the piston, subjected to the action of the powder-gases, is deduced from that of the known movement of a style-bearing slide displacing itself in a direction normal to that of the piston. More recently there has been a return to the employment of accelerographs, in which the movement of the piston is deduced from the tracing of the vibrating fork. We will describe briefly the arrangements peculiar to these different apparatus. Finally, from the commencement of the experiments on accelerographs, trial was made conjointly of apparatus called accelerometers, based on the same principle, but which indicated, at each experiment, only one isolated value of the pressure developed by the powder, corresponding to an arbitrary subdivision of the duration of combustion of the charge. These apparatus, which require the repetition of identical experiments for determining perfectly the law of the development of the pressures produced by the combustion of a charge of powder placed in certain definite conditions, have been applied to the study of the combustion of powder in a closed vessel, as well as to the study of the pressure developed in the bore of guns. But they have been more especially employed in this latter case by placing them in front of the initial site of the projectile for measuring the pressure existing against the "sabot" of this latter at the same moment when it attains a definite point of its passage in the bore, because one single experiment with this apparatus suffices, in this particular case, to show the value sought. Accelerometers should present different arrangements, according as they are intended to be mounted on fixed receptacles for the study of the combustion of powder in a closed vessel, or as it is proposed to mount them on guns; two principal types have therefore been established, the one denominated weight-accelerometers, and the other spring-accelerometers. Fork-accelerometers have also been employed for increasing the precision obtained. We will describe briefly these different types, as well as the apparatus which it was necessary to create for obtaining the "tarage."

Slide-accelerograph, used for studying the combustion of powder in a closed vessel.—It is known that the accelerograph is arranged in such a manner as to indicate the law of the movement of a piston, of known section and weight, bedded in a groove cut normally in the sides of the powder-chamber and subjected freely, on its base, to the action of the gases produced by the combustion of the charge. The apparatus registers the spaces passed by the piston each instant during the combustion, and consequently these passages can be exactly measured for very small and regularly divided intervals of time. The curve of the spaces traversed by the piston is thus determined by points in the function of times, and by a known process, which will be referred to hereafter, the law of the velocities acquired and the law of the accelerating forces to which the piston has been subjected can be deduced. According to these remarks, each chronograph apparatus should be composed of a piston of definite weight and section, moving in a suitable groove, of a table supported by the piston and designed to receive the registerings, and of a chronographic organ designed to produce these registering tracings. To these pieces must be added for the apparatus designed for studying the combustion of powder in a closed vessel, the chambers or eprouvettes designed to contain the powder and the preceding organs. Finally, all the apparatus are completed by the special instruments for the "tarage" and the readings. Fig. 1 represents an accelerograph arranged for the study of combustion in a closed vessel, and mounted for that purpose on apparatus which has received the name of eprouvette. This eprouvette is composed of a removable chamber of steel, with very thick sides, in which the powder subjected to trial is exploded. As a precautionary measure, this chamber is introduced in a bronze envelope, B, furnished with a lid. On this envelope is mounted the frame of the accelerograph proper, D. The steel chamber is closed by two screw-stoppers, arranged so as to form obturators to prevent the escape of gas. This obturation is obtained by these stoppers terminating in perfectly adjusted parts and hollowed in the form of basins, whose bevelled edges can sustain a certain expansion from the pressure of the gases, and the higher the pressure on the sides of the cylindrical passage which they should stop the more exactly do they fit. The gases are collected for analysis by means of a screw-cock, K. The lower stopper is traversed by a truncated plug of steel, perfectly adjusted, prolonged by a cylindrical bar and electrically insulated from the body of the stopper by the interposition of a leaf of gold-beater's skin glued with gum-lac. This plug supports in the interior of the chamber, by means of a prolongation in the form of a terminal, the extremity of a very fine platinum wire, whose other end is fixed on a similar terminal communicating with the body of the apparatus. This wire, raised to a red heat under the action of an electric current brought by the conductors, ignites the charge of powder with which it is placed in contact.

The upper stopper is traversed by an orifice in which is adjusted, with care, the piston whose movement is to be registered. This piston extends through the lid of the bronze envelope, and is screwed at its upper extremity into a cubic piece, T, which slides in the rectangular frame which is sustained by the lid. The piston and the cube that surmounts it form thus a movable body of known weight, susceptible of being freely displaced under the action of the force developed by the powder-gases, but only within the limit of the stroke which the height of the frame that serves as guide permits. In the upper face of the cube is fitted an India-rubber plug, which abuts against a screw of large diameter, W, which holds the frame at its upper part; the shock which results from the arrest of the movement is thus deadened. The screw may be let down more or less, thereby diminishing at will the that of the slide, which are affected in rectangular directions, have a strictly common origin. According to this arrangement, if we suppose that the piston alone is displaced while the slide remains stationary, the stylus will trace, on the left side of the table, a vertical line, following the same law of movement which it is the question to determine. If, on the contrary, we suppose that the piston is immovable and the slide liberated, the stylus will trace on the upper part of the table a horizontal line, following a law of a known movement. If the two movements are produced simultaneously, their combination will produce a tracing in the form of a regular curve in the direction of the angle formed by the two preceding right lines, which will serve as co-ordinate axes; and if we measure with precision the abscissas and the ordinates of the different points of this curve, the horizontal abscissas giving the durations of the trajectory of the stylus, since we know the law of its movement, we shall have the vertical strokes of the piston which correspond to these known durations, and consequently we can ascertain by points the curve of the spaces passed by the piston in the function of the times. The readings, according to the two co-ordinate rectangular axes, are made by means

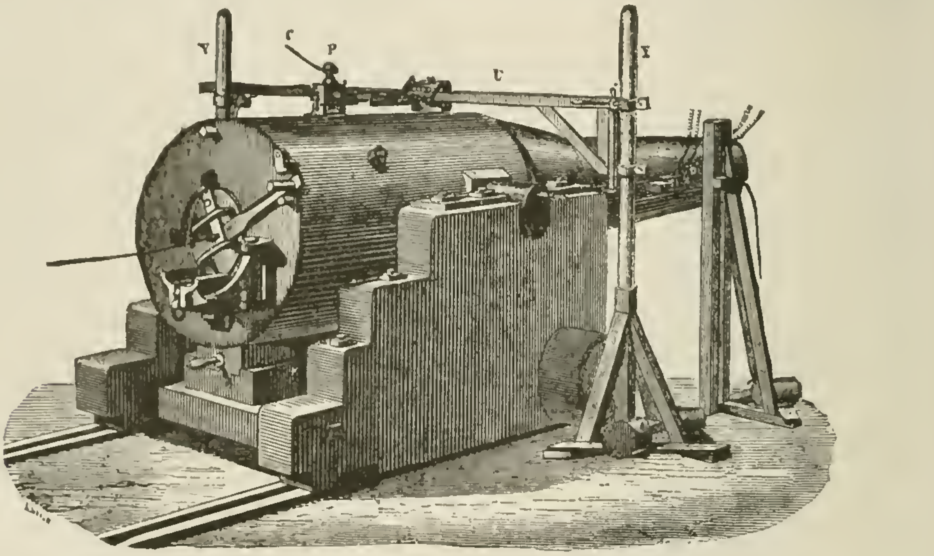


Fig. 2.

stroke from its extreme value, which is about 0.05 metres (1.968 inches). It is the law of the movement of the piston, or rather of the cube that surmounts it, which is the object to be registered. For this purpose a small square table of steel, or even of thick glass, covered with lamp-black, is fixed on one of the faces of this cube. In front of this table is arranged a small slide which has a stylus formed of a needle pressed by a small spiral spring, or, better, of a small flexible and finely cut steel pin. The slide slides between two parallel rails arranged horizontally, and in this movement its stylus traces a horizontal path on the table, on its upper part, if we suppose it to be immovable in its initial position. The slide is set in motion by the action of a trigger-spring, very rapid, which, in the apparatus represented by the figure, is nothing else than a strongly extended thong of India-rubber. The exact law of the movement which it takes under the influence of this spring is also known, as will be shown further on. It is kept, at the commencement of each experiment, at the extremity of its course by an organ arranged in such a manner as to liberate it at the precise moment when the piston is set in motion under the action of the powder-gases, so that the two movements, that of the piston and of a microscope, with crossed hairs, borne on a slide which can be displaced conformably to two rectangular axes, and which is set in motion in each of these directions by means of a micrometric screw. We can thus easily make the readings to the hundredth of a millimetre.

Slide accelerograph, employed for studying the combustion of powder in guns.—When the accelerograph is designed for measuring the pressures developed in guns, the piston is lodged in a steel bushing like those that are designed for the apparatus called crushers employed also for estimating the pressures produced by the combustion of powder. This bushing is screwed into a hole pierced in the sides of the gun, normal to the bore, at a point chosen for the purpose, and it terminates, on the outside, in a threaded head on which is screwed the frame which serves as guide for the cube designed to receive the table and as a support for the stylus-bearing slide. This frame and these organs may also be absolutely the same as in the powder-mill accelerograph, and the bushing which holds the apparatus may be placed in any position whatever, either in the vertical plane passing through the axis of the gun, or in any meridian plane inclined to the vertical. Fig. 2 represents an accelerograph installed on a 14-centimetre (5.51-inch) gun, model 1870, and placed in a vertical position. The slide represented by these figures differs from that described above, in that the apparatus is here arranged for registering the law of the recoil of the gun, as will be shown hereafter.

Fig. 3.

The only difference in signalling with the powder-mill apparatus, except this detail, is the arrangement placing the additional weight above the piston, when there is room, in order to increase, as occasion requires, the duration of the unobstructed stroke of the piston and to prolong it so as to continue the movement during an interval equal to that of the passage of the projectile in the bore. This weight, as it cannot, on account of the recoil movement of the gun, be guided by a stationary rod placed in the prolongation of the axis of the piston, as in the powder-mill apparatus, is here left free, and at the moment of the initial movement of the shot it is forced in the direction of the axis of the apparatus. If we suppose this latter to be vertical, as the figures show, the weight is forced vertically, but in consequence of the composition of the ascensional movement and that of recoil, it describes really a parabola, and it might fall on the gun if the precaution is not taken to attach it to the extremity of an elastic cord, of proper length, whose other end is secured at a fixed point. The tension of this cord, making it deviate from its plane curve, diverts it from the gun so that it strikes the ground at a distance from the carriage and the gun, which are thus preserved from the shock. This contrivance is not necessary if the lodgment of the piston of the accelerograph is placed in an inclined position in regard to the vertical; it is then only necessary for it to have, on the side, a sufficient space free to permit the projection of the weight. The necessity for employing a weight of this kind, if it is desirable that the apparatus should not reach the extremity of its path before the projectile has passed the whole length of the bore, is easy to demonstrate, and we can readily perceive that this weight ought to augment with the calibre of the gun, if we suppose the section of the piston to be constant and the free stroke allowed to the apparatus also invariable. We know, in fact, that if two movable bodies are subjected simultaneously to two forces which remain always equal to one another at each instant, but which, however, may be varied in some manner, the spaces traversed by these two movable bodies, under the influence of these forces, are constantly in inverse ratio of their mass. If, then, we suppose that the pressures developed in the chamber of the gun are exerted equally, at each instant, on all the elements of the interior of this chamber and, consequently, on the base of the piston of the accelerograph just as on the bottom of the projectile, we must admit, neglecting, however, the resistance opposed to the projectile by the forcing and the rifle-grooves, that the spaces passed at each instant by the projectile in the bore and by the piston of the accelerograph in its cylinder will be constantly in inverse ratio of the masses set in motion in each case, these masses being proportioned to the unit of surface. Now, in guns, the mass of the projectile referred to the unit of section increases with the calibre and also proportionally with this calibre, since if we suppose that the projectiles are similar, which is actually the case, their masses increase as the cube of the calibre, while the sections increase only as the square, so that the proportion of these two quantities increases as the first power of the calibre. If, then, for a given calibre, the dimensions of the accelerograph have been calculated so that the duration of the passage of the free stroke, the greatest that can be allowed it, is precisely equal to the duration of the passage of the projectile in the bore, it will be necessary in passing to a greater calibre to augment proportionally to the calibre the total mass of pieces set in motion, in order to continue to satisfy the same condition, and supposing that neither the stroke nor the section of the piston of the apparatus is changed. In the apparatus constructed, when a piston of half a centimetre square in section is employed, to which a free stroke is allowed of 5 centimetres (1.968 inches), the weight of the cube alone, which is about 4 kilogrammes (8.818 pounds) without additional masses, secures for the 14-centimetre (5.512-inch) gun, a registering duration nearly equal to that of the passage of the projectile in the bore; it is then only on departing from this calibre that it is necessary to employ additional masses to make the two durations correspond. By not making use of these masses we accelerate the movement of the piston and obtain in consequence greater precision in the tracing of the curve of the passage, but this tracing then applies only to a limited fraction of the duration of combustion of

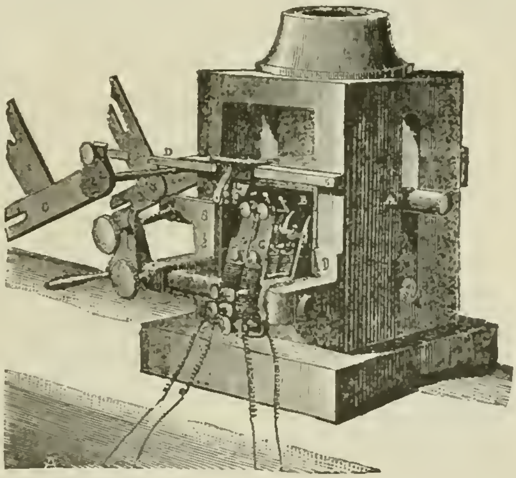


Fig. 4.

the charge. We can, moreover, without at all touching the other organs of the apparatus, vary at will the proportion of this duration of registering to the duration of combustion of the charge by changing the section of the piston; for this purpose the apparatus can be furnished with bushings and pistons of different dimensions.

Slide-accelerograph, employed for determining the law of the recoil of the gun.—In what precedes there was no notice taken of the influence exerted by the recoil movement of the gun on the movement of the accelerograph-slide, which serves to give the measure of the times. Now, it is easy to perceive that this influence is far from being unimportant and that it ought to be taken into account. If we suppose the plane of the accelerograph table to be adjusted parallel to the plane of fire, it is evident that the point of attachment of the extremity of the spring which operates the slide, which point is sustained directly by the frame of the apparatus in the simple accelerograph previously described, will be influenced in the recoil movement of the gun, while the style-bearing slide will be displaced in space. The displacement of the gun while the projectile is passing through the bore is, in fact, far from being unimportant, as has been admitted for some time, and it will be found that for a 24-centimetre (9.45-inch) gun, for example, it is nearly 30 millimetres (1.1811 inches). The tension of the India-rubber which causes the movement of the slide will then be diminished, in consequence of the inertia of this slide and of the spring also, if the point of attachment is turned towards the muzzle of the gun, so that the recoil is produced in a direction the inverse of the movement of the slide. On the contrary, it will be augmented if the apparatus is turned inversely; that is to say, if the point of attachment of the spring is placed towards the breech, so that the movement of the slide and the recoil movement are both directed the same way. It would be too difficult to take into account this disturbing effect whose causes are complicated, and it is more natural to seek to eliminate it altogether by giving to the apparatus a suitable position. The idea naturally occurs to the mind to adjust the apparatus in such a manner that the plane of the table may be normal to the plane of fire; under these conditions the slide is influenced in the recoil movement by its bearing on the guides, and its inertia cannot make it modify directly the tension of the spring which influences it. It was under these conditions that the experiments of Nevers were made in 1874, and it was also in this manner that the tracings reproduced above were obtained. But on applying the calculation to the results obtained by these tracings, it was easily seen that the recoil movement, in spite of the precaution taken in adjusting the table, still disturbed the work-

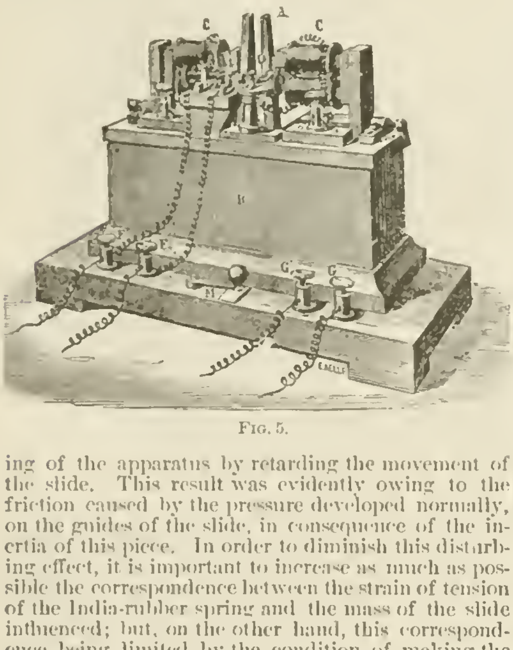


FIG. 5.

ing of the apparatus by retarding the movement of the slide. This result was evidently owing to the friction caused by the pressure developed normally, on the guides of the slide, in consequence of the inertia of this piece. In order to diminish this disturbing effect, it is important to increase as much as possible the correspondence between the strain of tension of the India-rubber spring and the mass of the slide influenced; but, on the other hand, this correspondence being limited by the condition of making the stylus pass over the width of the table in a time nearly equal to that required by the table in moving vertically over the extent of the free path of the apparatus, we are not at liberty to dispose of this element at pleasure. The inertia of the India-rubber spring, which, notwithstanding its small bulk, inclines to take a certain curvature through the effect of the recoil, presents also a disturbing element which it is utterly out of the question to take into account. It therefore is preferable to seek a different arrangement of the apparatus which eliminates all these causes of error. Now, if we suppose the table to be placed parallel to the plane of fire, and if we make stationary the point of attachment of the spring which sets the slide in motion, by fixing, for example, this point of attachment on a support independent of the slide, and placed near the gun, we see that the movement of the slide will be no longer altered through the effect of inertia; but, on the other hand, the table being drawn in the recoil movement, while the slide is displaced in space as if there was no recoil, the tracing given by the stylus will no longer be the same as that which was obtained before; the horizontal abscissas of the curve traced on the table will be, in fact, each instant, the sum of the passages of the stylus and the displacements of the gun in its recoil movement, if we suppose the point of attachment of the spring placed on the side of the muzzle of the piece, or the difference of these same quantities if we suppose this point placed on the side of the breech. It would therefore be necessary to know at each instant the displacement due to the recoil of the gun, in order to deduce from the curve traced the curve that would have been obtained if there had been no recoil. Now, it is easy to obtain, on the same apparatus, placed in this position, a curve that would show for each of the positions of the piston in its vertical displacement the quantity that the gun recoiled at the corresponding instant. It suffices, in fact, to fit on the table a stylus absolutely stationary in the space, that is to say, sustained by a support independent of the gun and the slide, in order that the table which becomes displaced before this stylus, by virtue of its two combined movements, may receive a new curve the ordinates of which will be the passages of the piston and the abscissas the passages of the gun. But as the gun in recoiling is subject to tremulous movements which might not always permit the stylus to rest in contact with the table, and which might also change the form of the curve, it is necessary to describe a right line on the table in its relative movement with the stationary stylus; and for this purpose it is mounted on a small slide which slides between two rails supported by the frame of the accelerograph. In order to keep it stationary between these rails it must be secured by a rod to a horizontal wooden cross-piece, supported by two stationary guide-posts, and passing over the gun.

Practically, in order that the same table may not be crowded with tracings, two similar tables are installed on the opposite faces of the cube pushed by the piston; and the stationary stylus, as well as the rails which hold it, are placed on one of the faces of the accelerograph-frame, while the rails guiding the movable slide are fixed on the other face. Fig. 2 represents an accelerograph apparatus mounted in this fashion on a 14-centimetre (5.51-inch) gun, model 1870. This apparatus is surmounted by an additional weight, retained by a cord; and in Y we see the uprights which sustain the cross-piece, U, to which are fixed on one side the point of attachment of the spring of the movable slide, and on the other side the steel plate the extremity of which bears the stationary stylus. The movable slide presents, besides, a very complicated arrangement, and it remains to show the object of it. If we retained the movable slide arranged as formerly, that is to say, attached directly to the India-rubber tension-spring, and although we have no more fear of the disturbing effects owing to the inertia of the slide and the spring, in consequence of the precaution that we have taken to fix the point of attachment of this spring to the stationary cross-piece, it might still happen that, under the influence of the concussion imparted to the gun at firing, and which makes the guide-bars which guide the slide vibrate, these guide-bars might pinch the slide between them and release it alternately, thus preventing it from taking the regularly accelerated movement which the India-rubber is calculated to impart. This is, indeed, what happened in the first trials, and a regular movement of the slide was obtained at first only for a very short time, which corresponded probably with the time employed by the powder in developing all its power and forcing the projectile in the bore, until the moment when, by the effect of the expansion, owing to the notable displacement of the projectile, the reaction of the sides of the piece causes the first vibrations of the metal. The curve traced on the table, after a very faint regular bend, presented all at once a distinct protuberance, denoting a sudden retardation of the slide. In order to obviate this inconvenience, we have formed the slide of two pieces, the one very light, bearing the stylus and running in very solid guides fixed on the frame; the other, much heavier, running in the guides supported by the wooden cross-piece and consequently fixed in space. The two slides are secured by a steel wire, flexible in every sense, but inextensible, so that the small slide may receive, in the direction of the guides, a movement identical with that of the large, notwithstanding the concussions of the gun, and it is on the heaviest slide that the tension-spring is fixed which produces the movement. We apprehend that, in this manner, we can give sufficient resistance to the guides of the small slide for them to yield a little under the effect of the vibrations, and sufficient solidity to the large motor slide so that the movement of this slide cannot be sensibly changed by the feeble relative resistance which the small "style-bearing" slide can oppose to it. We have said that the apparatus thus arranged furnishes two curves on the tables borne by the opposite faces of the cube pushed by the movable piston. One of these curves, that given by the slide drawn by the India-rubber spring, has its abscissas or horizontal co-ordinates, which are, at each instant, the sum of the displacements of the slide in the space and the horizontal displacements of the gun in its recoil movement; the other has its abscissas equal, simply, to these latter displacements. If we put on the successive abscissas of the first, the values equal to the abscissas of the second, we obtain, by the difference, the curve that would have been traced if the gun had not recoiled during the vertical displacement of the piston of the apparatus; that is to say, the curve by which the law of the movement of the piston is made known, in the function of the known law of the movement of the slide working separately, and consequently in the function of the times. By this known law is deduced, from the second curve, the law of recoil of the gun in the function of the times. Although the accelerograph just described is not furnished with organs for registering the moment of the departure of the projectile from the bore, we can, by the aid of the curves which it gives, estimate with a degree of precision the duration of the passage in the bore and deduce therefrom the quantity which the gun has recoiled while the projectile was passing through the bore. We know, in fact, that if we neglect the effect of the mass of the powder-gases, which, it is true, introduces a certain cause of error, we may admit that the projectile and the gun, including its carriage, must be displaced in an inverse direction, each instant in quantities inversely proportional to their respective masses. We may then, knowing the displacements of the gun, deduce therefrom the corresponding displacements of the projectile and, consequently, obtain the displacement of the gun corresponding to the passage of the projectile through the bore.

Electric register-accelerograph maintained by vibration.—The reading of the results obtained by means of the slide-accelerographs is long and difficult. As we have said, it is necessary at first to measure, by means of the microscope with double micrometric screw, the ordinates of the curve of "tarage" which correspond to the abscissas passed in the times increasing by equal fractions (for example, by thousandths of a second), which abscissas are ascertained by calculation. It is necessary afterwards, by means of the microscope, to trace on the curve of firing the ordinates thus obtained, and to read the corresponding co-ordinates, according to the conjugate perpendicular axis. These readings must all be made to the hundredth of a millimetre, and we understand how the successive operations so delicate may cause accidental errors; in every case it reduces the final precision; it would then be advantageous to find a means of measuring the durations more convenient and more precise in its employment. The solution of this problem seemed to require the employment of vibrating plates, inscribing directly, on the accelerograph-table, the spaces passed during intervals of time, each equal to the period of vibration of the plate, and thus we were induced, from the first, as we said before, to place a vibrating plate on one side of the movable slide (Fig. 1). This vibrating plate, furnished with a pen which rested on the blackened table, was, before firing, diverted from its position of equilibrium by means of a screw mounted on a projection of the movable cube, and which barely touched on the extremity of the plate, so as to detach it abruptly, as soon as the cube received the least displacement. The plate gave besides a great number of vibrations, usually a thousand a second, and it was carefully "tared" beforehand by means of the drop-chronograph, by a process easily understood by examining Fig. 3. A is the vibrating plate fixed on one of the guide-posts of the chronograph; the small turn-button B serves to keep it in the state of initial tension; it is encountered by the falling movable weight and suddenly turned away by a projection, C, on this weight. On this is fixed a small blackened table, D, so placed as to be encountered in its passage by the vibrating pen which traces the undulations whose spacing measures the duration in the function of the velocity of the drop-weight. This

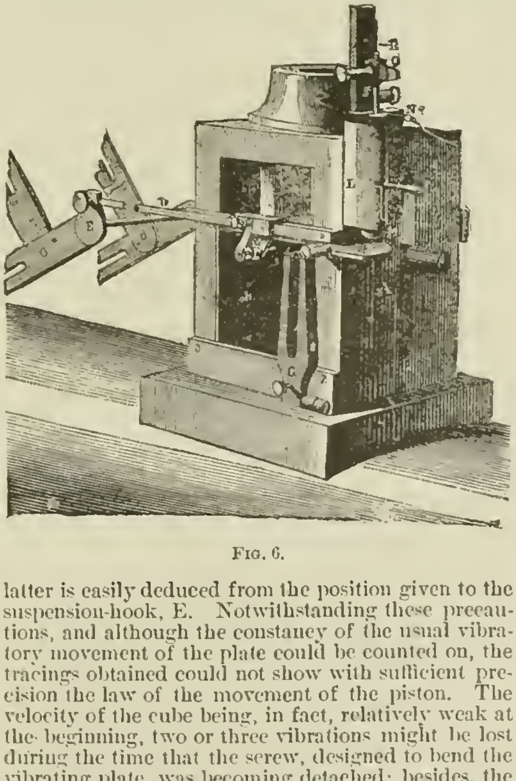


Fig. 6.

latter is easily deduced from the position given to the suspension-hook, E. Notwithstanding these precautions, and although the constancy of the usual vibratory movement of the plate could be counted on, the tracings obtained could not show with sufficient precision the law of the movement of the piston. The velocity of the cube being, in fact, relatively weak at the beginning, two or three vibrations might be lost during the time that the screw, designed to bend the vibrating plate, was becoming detached; besides, the regularity of the first vibrations of the plate was changed in consequence of the fact that the initial flexion, which was imparted to it by the pressure of the screw on its extremity, did not give it the same form that it takes in vibrating freely to the limit of its undulations, so that the first vibrations were employed by it to recover its natural state of molecular equilibrium, which, however, is very rapidly effected; it was necessary then to set aside these first defective vibrations, and it is precisely the movement registered by these first vibrations which it is important to know. On these two accounts it was proposed at first, as has been said already, to use the tracing of the vibrating plate only as a counter-register for testing if the accelerograph-slide had worked properly; a material disagreement between the total durations registered by the two apparatus must, in fact, indicate if the slide had sustained an unusual impediment, which, in certain cases, may be produced, either by the presence of grains of sand in the grooves which guide it, or even by the vibratory effect of those grooves under the influence of the firing, when the adjustage is too carefully made, or when the rails are too weak or too weakly supported on the apparatus. In order to lessen the inconveniences pointed out, trial was made of a new mode of disconnecting the vibrating plate, by producing the flexion of it by means of a jointed lever, its extremity acting on it while a projection on the movable cube was applied under the lever, near its point of articulation; thus the displacements of the piston were amplified and the disconnection accelerated, but no remedy was presented for the disturbing effect of the first vibrations. In order to obtain more precise results and to suppress entirely the style-bearing slide moved by a spring, it was purposed to utilize the properties of the small electro-magnetic registers constructed by Mr. Marcel-Deprez, the motion of which is sufficiently rapid to permit their following the vibratory movements of a tuning-fork electrically sustained, and giving as many as 1000 vibrations per second.

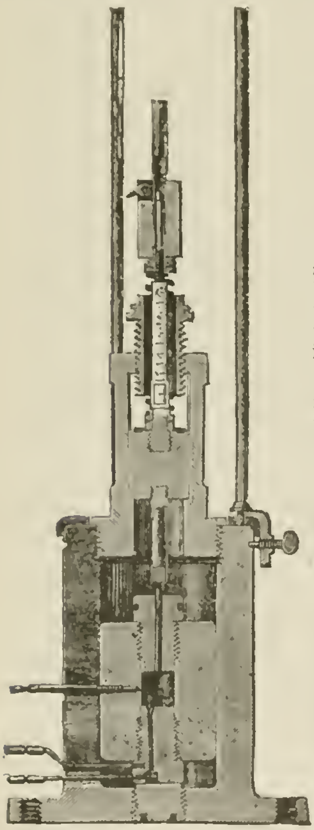
Fig. 4 represents the arrangement given to the apparatus in order to adapt it for registering the law of recoil of the gun, and also for measuring directly the duration of the trajectory of the projectile in the bore. The usual accelerograph-frame was retained, and for registering the rear face of the cube, B, was arranged to receive a second table, in front of which ran the stylus, secured by an inextensible wire, D, at a stationary point in space. In front of this face of the cube was mounted a cylindrical shaft, F, on which two small Marcel-Deprez registers, GG, were put; one of these registers was placed in a circuit passing through an interrupter fixed at the muzzle of the piece; the other was placed in a circuit passing through an interrupter-plate mounted on a fork electrically sustained and placed at a distance from the gun. When the fork was set in motion the current, passing through the electro-magnet, sustained at each period a rupture and a closure, so that the pen of the register, constantly resting on the table, took an oscillatory movement directed by that of the fork and strictly equal to it. The tracings of the pen were superposed as long as the table remained stationary; but as soon as the table was displaced, successive tracings were obtained, whose spacings indicated the displacements effected during each period. The fork was set in motion a little before firing the gun; on the shot leaving, there was found on the table a tracing left by the register directed by the fork and which gives the law of the movement of the piston, a signal given by the second register and which marks the space passed by the piston at the moment the projectile passes from the muzzle of the piece, and lastly a curve left by the stationary stylus and which shows the recoil of the gun each instant, in the function of the displacements of the piston. Fig. 5 represents the arrangement of the fork electrically sustained and designed to direct the movements of the vibrating register. On the examination of this figure we perceive that this fork, A, mounted on a cast-iron base, B, is sustained by means of two electro-magnets, CC, traversed by a special current and a flexible plate oscillating between two supporting screws, one a conductor, the other an insulator, arranged as has been previously shown. This plate, D, is fixed on one of the branches of the fork; the other branch bears symmetrically a similar insulated plate, E, supported, when the fork is at rest, against a metallic screw, and separating from this screw for an instant at each vibration of the fork. The plate is connected by a very fine flexible wire with a terminal, F, placed in the special circuit of the accelerograph-register; the supporting screw, communicating with the second terminal, F, is also placed in this circuit which is thus established by the contact of the plate and the screw, and interrupted on the cessation of this contact. By turning the screw slowly, the duration of the contact can be regulated at each period. The terminals, GG, serve to establish the current which sustains the movement of the fork, and the circuit passes through the handle, M, by which it may be interrupted at will. In the trials that were made, the fork and the batteries were placed a short distance from the gun, so as to have circuits only of small resistance; it was necessary to sustain the vibrating fork by means of these small model Delaurier elements, and four similar elements for each of the registers.

Electric fork-accelerograph.—This apparatus, which has been described, presented the inconvenience of not giving subdivisions of time sufficiently small to furnish with precision the value of the accelerating forces of the piston. Experience showed, in fact, that in order to calculate with sufficient precision the accelerations obtained during such a short space which corresponds with the development of the maximum pressure in the bore of guns, even those of large calibre, where this time is longest, it was necessary to descend, in measuring the times, below the thousandths of a second, and perhaps even to reach as far as five thousandths at the least. Now, it was practically impossible to make use of an electric fork directing a register and giving more than one thousand periods a second. A fork giving 1500 periods might, indeed, be electrically sustained, though not without difficulties; but the amplitude of these vibrations being very small, it was impossible to assure the regular movement of the interrupter-plate, and this sometimes missed its connection, which introduced irregularities in the movements of the register. As to this latter, the improvements effected by Mr. Deprez would have enabled it to give, in case of need, a greater number of signals per second than the limit sought, and there was no obstacle there. A new trial was made by employing an electric fork mounted directly on the accelerograph. The case and the piston of the accelerograph, as well as the table sustained by the latter, retained the same arrangements as before; but the shaft which contained the register directed by an exterior fork received directly a small diapason electrically sustained by the aid of an arrangement similar to that which has been already described; this arrangement is here fixed entirely on a metal frame, which contains the fork and which is movable with it on the support-axis, so as to permit the pen of the table to be brought nearer or separated at will, without prejudice to the vibratory movement. As long as the table is stationary, the tracings of the pen in motion are superposed and form only one mark; these tracings are separated and give a sinusoidal curve as soon as the table is set in motion under the action of the piston. A second stationary pen, on the support-frame, traces at the same time the median path, whose successive intersections with the sinusoid will give the spaces passed by the table during the corresponding periods. The results obtained with the fork-accelerograph, although superior to those given by the registering apparatus supplied by vibration, were not sufficient, however, and showed that it was necessary to seek to estimate still smaller intervals of time. The electric supply of a fork giving 2000 periods per second was, besides, very delicate. Its initial movement was tedious to obtain before each experiment, and it was rare that the apparatus could be kept without derangement in a working state during the whole continuance of a series. After having sought without success to solve the difficulty by the employment of a contrivance which would have given the means of subdividing, into a certain number of equal parts, the duration of each period of the fork, which might have admitted of preserving the last arrangement adopted, but by making use of forks giving only 1000 periods, and consequently easy to supply electrically, it was decided to try again the employment of the fork set in vibration mechanically.

Mechanical fork-accelerograph.—We have seen that in order to utilize a fork, vibrating mechanically at the moment of firing, for registering the displacements of the accelerograph-piston, it was sufficient to procure the initial movement of this fork a very little time before the projectile leaves the bore, so that, the vibrations having had time to regulate themselves when the piston sustained its first displacement, the origin and commencement of the movement could be registered without error. It is necessary, besides, that the discharge of the gun should follow very closely the initial movement of the fork, because if forks are used giving 2000 to 3000 vibrations, as those which are acknowledged to be necessary, these forks, set in vibration by an energetic shock, preserve only for a very short time, scarcely the tenth of a second, an amplitude sufficient to give proper tracings for the readings. Fire communicated by electricity gives, evidently, the solution of the problem, for we conceive that the mechanism whose release will produce the vibration might, in working, establish the current which will determine the inflammation, leaving, between these two operations, the interval strictly necessary to permit the vibrations of the fork to regulate themselves, without losing too much of their amplitude. Fig. 6 represents the application of this idea to an accelerograph which is arranged, with the exception of the organ for registering times, like those which have been previously described, and which consequently permits of measuring also the law of the recoil of the gun. A vibrating fork, G, is simply fixed in front of the table, whose branches are each furnished with a pen, in order the more surely to obtain a proper tracing. A wedge, H, on the extremity of a small, horizontal-jointed lever, can be forced between the branches of the fork and keeps them apart; it suffices to strike sharply on the other branch, K, of the lever in order to disengage it and make the fork vibrate; this latter then gives an acute sound which is perceptible only for a very short time. This shock may be produced in the apparatus by the extension of a spiral spring lodged in a small cylindrical box, L, fixed on the side of the case, and which suddenly pushes a percussion-lock, M, guided vertically through this box. The apparatus is cocked by raising the percussion-lock by means of a small handle, P, which passes through a vertical groove; this bends in the form of a knee to form a safety-notch. A pin, N, is then entered into a hole normally made in the spindle, which is an extension of the percussion-lock, and this latter is held only by the point of this pin, when the handle is moved back in the groove. By drawing away this pin, by the traction of a cord which is fixed to it, the working of the apparatus is produced. The precise moment of inflammation may vary within certain limits; in order to communicate the fire, the upper part of the spindle of the percussion-lock, which extends beyond the spring-box, is furnished with a metallic rubber, R, which may be fixed at a variable height by means of a pressure-screw, Q, and which rests upon an insulating rod terminated by a conductor, S, at its lower part. The metallic rubber of one part and the conductor of the other are put in communication with a firing-battery connecting with the electric percussion-tube of the gun, or with a platinum wire sunk in the charge, if the trial is made with a closed vessel. In consequence of this arrangement the circuit is closed only when the percussion-lock, pressed by the spring, brings the rubber in contact with the conductor-plate, and this contact is established at a moment which may vary, within certain limits, depending on the moment when the shock on the end of the lever produces the disconnection of the fork. The closing of the circuit may be made to precede the shock if the retardation of inflammation of the charge is relatively considerable, or, on the contrary, to follow it if the inflammation must be very prompt.

ACCELEROMETERS.—Accelerometers show, by direct registry, the law of the movement in the function of time of a piston subjected to the action of powder-gases. It has been seen in studying the accelerographs that an additional weight placed on this piston in such a manner that it may be thrown vertically without obstacle, when this latter is suddenly stopped, can show, by a single observation, the velocity acquired by the piston up to the end of its stroke. In fact, this weight, thrown freely and preserving the velocity which it had in common with the piston, will be raised to a height, h, given by the relation $v^2=2gh$, so that the observation of the height of the vertical stroke h will show the velocity v. If it is admitted that the phenomena of the combustion of the powder are reproduced identically in the like conditions, and if a series of detonations are effected with a constant charge, but varying the free stroke each time, which will be obtained, for instance, by lowering successively the stop-screw W, in Fig. 1, in the article ACCELEROGRAPHS, it is evident that the observation of the corresponding heights of throw of the additional weight supported by the piston would show the successive velocities acquired by this piston according to the gradually diminishing paths. We could then determine, by this simple process, and without a special chronometric organ, but on condition of repeating the experiments, the law of movement imparted to the piston. Mr. Marcel-Deprez, from the first, proposed the employment of apparatus of this kind, which appeared more easy to realize than accelerographs, and he gave them the name of accelerometers. In principle, these apparatus are composed of a piston of a certain weight, subjected freely to the action of the powder-gases, and for which a variable stroke may be allowed, exactly regulated each time; this piston must be provided, moreover, with arrangements for measuring the velocity acquired at the end of the stroke. For stationary apparatus, susceptible of being placed vertically, like those which may be installed on eprouvettes, the measure of the final velocity can be obtained simply by the observation of the height of the throw of an additional weight, as has been already explained. For apparatus designed to be placed on a gun, and which must consequently be subjected to the violent effects of recoil, an arrangement of this kind could not be employed, and Mr. Marcel-Deprez was obliged, in view of this particular case, to seek another means of measuring the velocity. By employing always an additional mass borne by the piston and thrown by it with the velocity which it is sought to determine, he pointed out two different processes, both very simple, for obtaining this measure. In one of the systems, the weight thrown, guided by a rod which passed through its axis, must meet with a constant resistance which could be regulated at will; in this case, the passage of the weight on the rod must be theoretically proportional to the square of the velocity, or if a constant antagonistic resistance could not be absolutely counted on, it would be necessary, by a previous "tarage," to determine the relation existing between the observed paths of the weight on the rod and the corresponding initial velocities.

In the second system proposed by Mr. Marcel-Duprez, we must oppose to the weight freely thrown, and always guided by a central rod, a variable resistance, but one known at each instant, as, for example, that which the compression of a spring develops; in this case, however, we may, for a spring and a given weight, determine, by a previous "tarage," the relation which connects the initial velocities with the paths necessary in order to attain them. We can also, by choosing springs susceptible of causing a variable resistance according to a simple law, ascertain that a law equally simple connects the velocities with the paths. If, for example, we suppose that the energy exerted by the antagonistic spring varies proportionally to the passages of the weight, measured on its leaving a fixed point situated on the trajectory of this latter, we can observe that the paths producing the stopping of the weight are rendered directly proportional to the initial velocities. The trials undertaken with the object of realizing the first system did not succeed; a slide has not yet been constructed running on a metallic rod on which a definite and strictly constant friction could be exerted over the whole length of its course. If that construction had been realized, we could, by letting the rod, furnished with its slide, fall vertically and from increasing heights, on an unchangeable obstacle, have obtained the paths of the slide proportional to the heights of fall, under the influence of the shock caused by the sudden stopping, since the velocities acquired in the fall of bodies are themselves proportional to the square roots of the heights of fall. But this result was far from being attained, and notwithstanding all the care taken in dressing and polishing the surfaces in contact, it was settled that the friction depended on causes too numerous and on influences too difficult to estimate for it to be possible to obtain results sufficiently regular; we found, in fact, that the adhesion at the departure being, in all cases, greater than during the movement, the slide, after having passed over a small space, with a very small velocity, afterwards took a velocity sensibly greater and a much longer path than was reasonably expected and without even giving regular values. Under these conditions we must depend upon the employment of the spring to weaken the velocity of the additional weight, when, by the arrangement of the apparatus, this detached weight is not left to the action of gravity alone, where we must operate on masses in motion, as in the firing of guns, or where the locality does not permit the installation of proper guides for measuring the vertical height of the weight. More recently use has been made of vibrating forks leaving on the additional mass thrown traces sufficient in number to determine the value of its initial velocity. The accelerometers which have been constructed may be distinguished as weight-accelerometers, spring-accelerometers, and fork-accelerometers; the two latter only can be mounted on guns. Simple accelerometers may also be distinguished, that is, those which contain only the organs designed for measuring the final velocity of the piston, and the accelerometers combined with accelerograph-organs, like those of which we have already spoken above. In these latter the accelerometer arrangement is usually employed only as a counter-register of the course of the accelerograph, and a few complemental details will suffice to explain the function of the organs represented by the figures which we have already appropriated to these apparatus. We will give these explanations directly and afterwards describe, more in detail, the arrangement of the simple accelerographs by referring to the mode of their employment.



The first powder-mill accelerographs constructed were arranged in such a manner that they could be used as weight-accelerometers by making use, in order to limit the stroke of the movable piston, of a screw by which this stroke could be reduced to a very small value and graduated at will. The registering of the height of the "cast" is obtained by arranging in the axis of the apparatus a vertical rod guiding the additional mass thrown; this rod is provided with a light slide of leather or felt, impelled with a very slight friction by this mass in its ascensional movement. The drawing represents, in section, an apparatus on which are placed simultaneously two different arrangements for measuring the final velocity of the weight; one of these arrangements is, like the preceding, a vertical rod guiding a slide impelled by the additional weight, which is provided with a Dobo ratchet-catch to prevent its falling violently on the piston; the other is a spring apparatus consisting of a spiral spring put on a rod which makes part of the piston and participates in all its movements. The upper part of this spring is fixed to the rod; its lower part is terminated by a mass of certain weight which rests freely on the head of the piston and is thus cast upward, when this latter stops, with the velocity which is to be determined. Thus this mass compresses the spring until its velocity is terminated, then the spring in recoiling pushes it back in its place. We apprehend that for a given spring and mass we might by a preliminary tarage determine the quantity of the compression of the spring for the successively increasing velocities, so that it may be easy afterwards to deduce from an observed compression the value of the velocity which produced it. We shall see further on how this tarage may be effected. In the apparatus represented in the drawing, in section, in order to determine the quantity of the compression of the spring in each experiment, there is placed on the mass which terminates the lower part of the spring a small slide forming a vernier, which slides with a slight friction on the central rod, which is divided into millimetres. This slide is pushed by the mass in its ascensional movement and abandoned by it when it redescends after having lost its velocity. The mass of the slide is so small that it could not sustain a throw which would push it beyond the position which the mass itself has reached, so that the division at which it stops may give the exact measure of the compression of the spring. If the place at our disposition does not admit of placing above the eprouvette a vertical rod to guide the weight thrown, the spring-system may suffice, which requires only a small height, by suppressing entirely the additional weight with ratchet mechanism; we may also, in this way, use a lighter piston and obtain greater velocities for smaller distances. If, on the contrary, we adopt the double system, we have the advantage of obtaining, for the measure of the final velocity of the piston, two values which must correspond. The spring arrangement may also be applied to accelerographs mounted on a gun, and give also in this case a check measurement for the final velocity of the piston. See *Accelerographs*.

ACCESSIBLE.—Easy of access or approach. A place or fort is said to be *accessible* when it can be approached with a hostile force by land or sea.

ACCESSORY MEANS OF DEFENCE.—The means employed as *accessory* usually consist of artificial obstacles, so arranged as to detain the enemy in a position where he will be greatly cut up by the fire of the work. Anything may be regarded as an obstacle to the enemy by which his attention is diverted from the assailed to his own situation; but no obstacle will be of much service to the assailed which is not within good striking distance of his weapons. The proper disposition, therefore, of obstacles is in advance of the ditch within short musket-range. Here they delay the assailant under fire, and give the assailed a feeling of more security as the assailant is kept further off. Marshes, water-courses, wet ditches, precipices, etc., may be regarded as obstacles, if they are sufficient in themselves to stop the enemy's progress. But, however strong, they are not solely to be relied on; as the strongest natural position may be carried if not vigilantly guarded.

In placing the ground around a work in a defensive attitude, every means should be taken to reduce to the smallest possible number the points by which the enemy may approach, so that, by accumulating the troops on the weak points, a more vigorous defence may be made. In making this arrangement, equal care should be given to everything that, affording a shelter to the enemy, would enable him to approach the work unexposed to its fires. To prevent this, all hollow roads, or dry ditches, which are not enfiladed by the principal works, should be filled up, or else be watched by a detachment, covered by an advance-work. All trees, underwood, hedges, enclosures, and houses, within cannon-range, should be cut down and levelled, and no stumps be allowed higher than two feet. Trees beyond cannon-range should not be felled; or if felled, they should be burnt, to prevent the enemy's movements being concealed. If there are approaches such as permanent bridges, fords, and roads, which may be equally serviceable to the assailed and to the enemy, they should be guarded with peculiar care, and be exposed to the enfilading fire of a work especially erected for their defence. See *Abatis*, *Chevaux-de-frise*, *Crow's-feet*, *Entanglements*, *Fraises*, *Inundations*, *Mines*, *Palisades*, *Small Pickets*, *Stockades*, and *Trous-de-loup*.

ACCIDENTAL LINE OF OPERATIONS.—Lines of operations are sometimes employed, different from those proposed in the original plan of campaign. To these lines the term *accidental* is applied. It does not follow that their adoption is a matter of accident, as might be inferred from their name. They are frequently the result of a change in the original plan, which probable change was foreseen and provided for.

ACCIDENTAL OBJECTIVE. — Accidental objectives are dependent upon the military operations which have for their object the destruction or disintegration of the enemy's forces. The position of the enemy determines their location. Thus, if the enemy's forces are greatly scattered, or his front much extended, the central point of his position would be a good objective point, since the possession of it would divide the enemy's forces, and allow his detachments to be attacked separately. Or, if the enemy has his forces well supported, a good objective would be on that flank the possession of which would allow his communications with his base to be threatened. It is well to remark that the term "point" generally used in this connection is not to be considered merely in its geometrical sense, but is used to apply to the *object* which the army desires to attain, whether it be a position, a place, a line, or even a section of country.

ACCIDENTAL STRATEGICAL POINT. — A point whose possession will give an advantage over the enemy, causing him to fight at a disadvantage, or retreat, is an "accidental strategical point," since it is frequently dependent upon the positions of the contending forces at a particular time. It is generally a "decisive point," for its possession insures success for the military operation with which it was connected.

ACCINTUS.—A word in ancient times signifying the complete accoutrements of a soldier.

ACCOLADE.—The term applied to the ceremony with which a knight was admitted into the Order of Chivalry. The Grand-Master, in receiving the neophyte, embraced him by folding the arms round the neck (*ad collum*).—In music, the accolade is the couplet uniting several staves, as in part-music.

ACCORD.—The conditions under which a fortress or command of troops is surrendered.

ACCOUNTANT-GENERAL OF THE ARMY.—An officer in the English service who has the control of military finance. He includes in his office that of Chief Auditor, an amalgamation with that of Accountant-General, which took place by order of the Secretary of State for War in 1870.

ACCOUNTS.—The systematic record of public expenditures. In the United States service, all officers, agents, or other persons who are charged with the safe-keeping, transfer, or disbursement of the public moneys keep an accurate entry of each sum received, and of each payment or transfer; and render distinct Accounts of the application thereof, according to the appropriation under which the moneys may have been advanced to them. Every officer or agent who, having received public money which he is not authorized to retain as salary, pay, or emolument, fails to render his Accounts for the same is deemed guilty of embezzlement, and is fined in a sum equal to the amount of the money embezzled, and is imprisoned not less than six months or more than ten years.

The following rules for computation of time are observed, when preparing Accounts for settlement:

1. For any full calendar month's service at a stipulated monthly rate of compensation (or yearly rate, if paid in regular monthly or bimonthly installments), payments are made at such stipulated rate, without regard to the number of days in that month.

2. When service *commences* on an intermediate day of the month, 30 days is assumed as the length of the month, whether the calendar length be 28, 29, 30, or 31 days, and pay allowed accordingly.

3. When the service *terminates* on an intermediate day of the month, the actual number of days during which service was rendered in that calendar month is allowed in payments.

4. When the service embraces two or more months, or parts of months, but one fraction is made. Thus, from September 21 to November 25, inclusive, is calculated September 21 to October 20, inclusive, one month; from October 21 to November 20, inclusive, one month; from November 21 to 25, inclusive, five days—making the time allowed two months and five days.

5. When two fractions of months occur, both together less than a whole month, as from August 21 to September 10, the time is determined thus: August 21 to 30, inclusive (ignoring 31st), ten days; from September 1 to 10, inclusive, ten days—making the time allowed twenty days.

6. Service commencing in February is calculated as though the month contained 30 days, thus: From February 21 to 28 (or 29), inclusive, ten days; but when the service commences on the last day of February, only one day is allowed in that month.

7. For commutation of subsistence, and for services of persons employed at a per-diem rate, payment is made for the actual number of days.

8. When service is rendered from one given date to another, the Account must state clearly whether both dates are included.

The Accounts of disbursing officers of the Army are kept in the offices of the Auditors of the Treasury by fiscal years; therefore no Account Current should contain mixed accounts, and no item should be entered thereon unless it pertains to the fiscal year to which the funds are chargeable, and *all accounts current, abstracts, and vouchers, including transfers and refundments,* should have noted in red ink on the face, as well as indorsed in the brief on the back, the fiscal year to which the funds pertain.

ACCOUNTS-CURRENT.—Running or continued accounts between Disbursing Officers and the Government Accountant Officers. In the United States service, the law requires that a separate account be kept with each appropriation disbursed. The forms of Account-Current and abstracts prepared for this purpose and approved by the Second Comptroller of the Treasury are used by disbursing officers. The Account-Current is made in duplicate; one copy, accompanied by abstracts and vouchers complete, is forwarded to the chief of Bureau within ten days after the end of the month; the other copy, also accompanied by abstracts and vouchers, is retained by the officer. Funds received from overpayments previously made are entered on the Account-Current in the proper column. The entries should show by whom and to whom the overpayments were made, on what account, and refer to the voucher and abstract. Funds received on account of overpayments made from appropriations not now controlled by the chief of their Bureau, except as hereinafter provided, may be entered under any head of appropriation on the Account-Current. All funds received from sales, refundments, or miscellaneous sources, are at once deposited in the nearest United States depository to the credit of the Treasurer of the United States on account of the appropriation to which it belongs, if any, and receipts taken therefor; the original receipt is forwarded to the chief of the Bureau, accompanied, if possible, by information showing to what particular appropriation the money belongs, and for what year. For funds thus deposited, officers take credit on their Accounts-Current. Accounts-Current should, when practicable, cover monthly periods only. They may, however, if necessary, be stated at intermediate dates when rendered to close accounts on renewal of bond, change of station, or taking advantage of leave of absence of more than ten days. In these cases the officer must make an actual *bona fide* transfer of his entire balance of public funds. The Account-Current must exhibit the receipts and expenditures for the period embraced, and must state the place or places where the balance due the United States is deposited. The amounts received and disbursed and the balance on hand under the several appropriations of each fiscal year must be exhibited. In crediting drafts on the Account-Current the *number of the requisition*, as indicated on each draft, is carefully noted in the credit entry.

The following is a form of Account-Current used in the Subsistence Department:

and plate, cartridge-box belt and plate, waist-belt and plate, gun-sling, bayonet-scabbard, and cap-pouch; to which, on a march, are added the knapsack, canteen, and haversack. Two loops are attached to the back of the cartridge-box for the passage of the belt, which passes diagonally across the body in front and rear from the left shoulder to the right side, where it passes beneath the waist-belt, and is secured to the cartridge-box by two buckles. For ornament a round brass plate (in the United States stamped with an eagle) is attached to this belt, so as to fall about the centre of the chest of the wearer. More frequently the plate bears the number of the regiment or the letter of the company. The waist-belt, as its name implies, passes around the waist, and carries the bayonet-scabbard and cap-pouch; it also serves to keep the cartridge-box and belt in place close to the body; it is fastened by a brass plate. The bayonet-scabbard is made of black bridle-leather; it has a shape to fit the bayonet, and is provided with a brass ferrule at its bottom for ornament and protection; a leather loop, or *frog*, is attached to the upper part of the scabbard for inserting the waist-belt. The cap-pouch is also made of black bridle-leather, and has a flap and inner cover, the flap being fastened by a brass button. The pouch is lined with sheepskin with the wool on, to prevent the caps from being jarred out and lost when the flap is not buttoned. The gun-sling is of russet bag-leather, 1¼ inches wide and 46 inches long; it has a standing loop at one end and a brass hook at the other, with a sliding loop between. All belts in the United States land service are black, and are made either of leather or of a strong species of felting, called *buff*, probably because belts were formerly made of that color. Until within a few years a separate belt was used for suspending the bayonet-scabbard, passing over the left shoulder and crossing the cartridge-box belt diagonally on the breast, which was ornamented with a plate at the crossing. The cartridge-box belt has sometimes been dispensed with, particularly for riflemen, the whole weight of the accoutrements, with, in this case, the addition of a heavy sword-bayonet and scabbard, being borne by the waist-belt, which of course had to be drawn very tight, forcibly com-

The United States, on account of Subsistence of the Army, in the month of ——, 188 , in account with —— Lieut. —— ——, —— Regiment of ——, A. A. C. S.

Dr. Cr.

188 .		Dolls.	Cts.	188 .		Dolls.	Cts.
	To amount disbursed, per Abstract of Purchases........				By balance per last Account-Current........		
	To amount disbursed, per Abstract of Contingencies........				By sales to officers for cash, per Abstract...		
	To amount transferred to ——, per receipt				By sales to enlisted men for cash, per Abstract........		
	To amount transferred to ——, per receipt				By sales to companies, detachments, and hospitals, per Abstract........		
					By sales to ——, per Abstract		
					By sales of stores at auction, per Abstract..		
					By sales of barrels, boxes, hides, etc., per Abstract........		
					By transfer from ——, per invoice ——		
					By transfer from ——, per invoice ——		
					By Treasury Draft No. —— on War Warrant No. ——		
	To balance due the United States........						

I certify that the above Account-Current exhibits a true statement of all moneys received, expended, and transferred by me on account of Subsistence of the Army, not heretofore accounted for; and that the balance of —— dollars and —— cents is due the United States by me, and is deposited as follows:

With the Assistant Treasurer U. S. at —— $ ——

With the —— National Bank of —— ——

In transitu —— ——

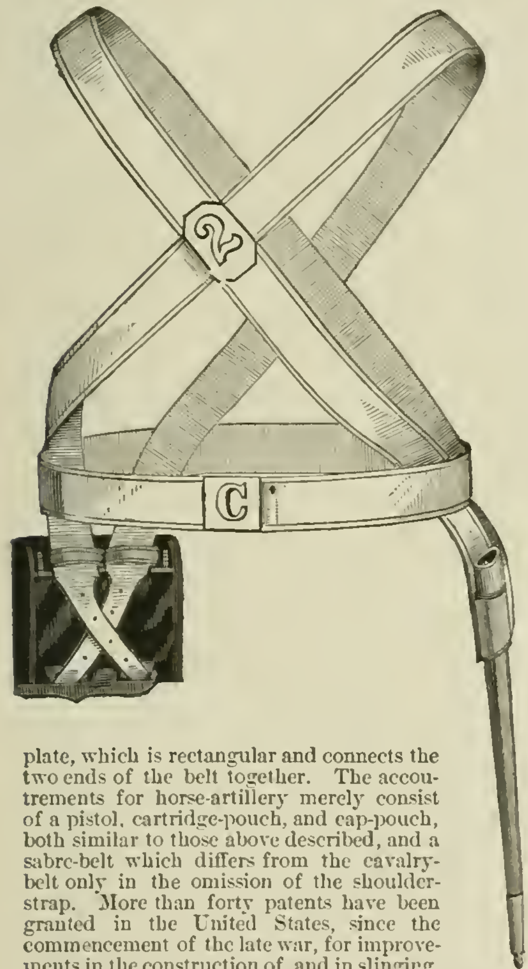
In my personal possession, deposited in office safe —— ——

Total ——

——, ——, *Reg't of* ——, *A. A. C. S.*

ACCOUTREMENTS—ACCOUTERMENTS.—The devices by which a soldier carries his arms, ammunition, etc. These vary in the different arms of the service according to the exigencies of the case. Those for infantry usually consist of a cartridge-box

pressing the abdomen, and causing great and unnecessary fatigue, or even permanent injury. This arrangement was, we believe, generally condemned by the Medical Department and in fact, by every one who thought on the subject; but as the weapon above mentioned was in very limited use, toward the close of the war especially, the evil was not so general as it might have been. The cartridge-box for cavalry resembles in exterior appearance that for the infantry, but is smaller, and its two loops are arranged so as to pass the sabre-belt through them. Those used by the troops in the late war were variously arranged in the interior to suit the supposed necessities of the cartridges of each particular kind of carbine, as Burnside's, Merrill's, etc. The cavalryman is also provided with a small box or pouch for revolver-cartridges and a cap-pouch. The sabre-belt, to which all the preceding are attached, consists of a waist-belt, with two brass rings for the shoulder-strap and sabre-slings, and a brass loop sewed at one end to receive the



plate, which is rectangular and connects the two ends of the belt together. The accoutrements for horse-artillery merely consist of a pistol, cartridge-pouch, and cap-pouch, both similar to those above described, and a sabre-belt which differs from the cavalry-belt only in the omission of the shoulder-strap. More than forty patents have been granted in the United States, since the commencement of the late war, for improvements in the construction of, and in slinging, accoutrements. The more important of these patents will be noticed under specific headings. The drawing shows the usual arrangement and adjustment of accoutrements. The Ordnance Department at present issues the following accoutrements to United States troops:

Infantry Accoutrements.—Bayonet-scabbard, leather; bayonet-scabbard, steel; cartridge-box; cartridge-box plate; cartridge-box belt; cartridge-box belt-plate; cartridge-belt, with buckle (belt of leather, covered with webbing, with loops of webbing), for calibre .45; gun-sling; shoulder or sword belt for non-commissioned officers or musicians; shoulder-belt plate; sliding frogs for waist-belts (for swords); waist-belt; waist-belt plate.

Cavalry Accoutrements.—Sabre-belts, buff leather, blacked; sabre-belts, grained leather, blacked; sabre-belt plates; sabre-knots; canteens; canteen-covers; carbine-slings, buff leather, blacked; carbine-slings, grained leather, blacked; carbine-sling swivels; carbine-cartridge boxes; carbine-cartridge pouches; cartridge-loops (worn on sabre-belt); haversacks; pistol-holsters, Smith & Wesson's; pistol-holsters, Colt's; pistol-cartridge pouches; snap-hooks; Stuart's attachments.

Sabre-belts and sabre-belt plates are issued as accoutrements for the artillery. The following directions should be observed for reblacking the leather parts of accoutrements: Brush them with a hard brush, to clean the surface; if they are very greasy, use a wire scratch-brush. Then, with a soft brush or sponge, apply the following mixture, viz.: one gallon soft water, two pounds extract of logwood, half a pound broken nutgalls, boiled until the logwood is dissolved. When cold, add half a pint of the pyrolignite of iron—made by dissolving iron-filings in pyroligneous acid, as much as the acid will take up. The dye thus made should be well stirred, and then left to settle. When clear, bottle it free from sediment, and keep it well corked for use. Dye the belts in the shade; then apply a little sperm or olive oil, and rub well with a hard brush. Should any bad spots appear, scratch up the surface with the wire brush, and wet two or three times with a simple decoction of gallnuts or sumach, and again apply the dye. Logwood is not essential, and a solution of copperas may be used instead of the acetate of iron.

ACCUMULATION OF POWER.—The quantity of motion in machines at the end of given intervals, during which velocity has been constantly accelerated. A simple case is the rammer of a pile driving machine, which descends by force of gravity in a certain time and falls upon some object. If the object does not move, the velocities of all the particles in the hammer, which had gone on increasing during the descent, are destroyed, and thus a shock is produced immensely greater than that which would result from the mere pressure of the hammer. The effect is directly proportional to the mass in motion, and to the square of the velocity at the instant of impact.

ACCUMULATOR.—An apparatus used in working hydraulic cranes and other machines where a steady and powerful pressure of water is required. The accumulator is intended as a substitute for a natural head, as being more compact. Sir William Armstrong, in the first applications he made of this principle to hydraulic cranes, employed a *natural* head of water as the motive agent, obtaining the same by pumping water into tanks at an elevation of about 200 feet; but subsequently he has employed the accumulator, as offering the advantages of greatly increased capacity for pressure, and a less prime cost of erection. The apparatus consists of a large cast-iron cylinder, fitted with a plunger, which works water-tight by means of a gland and packing. To this plunger is attached, by means of bolts and a strong cast-iron cross-head, a loaded weight-case. Thus a pressure is obtained upon the water in the cylinder equal to a column of water 1500 feet high, or 660 pounds upon the square inch. As the water is pumped into the cylinder by the pumping-engine, the piston with the weighted case rises, being guided by a strong framework, and is made to regulate the amount of water pumped in by actuating a throttle-valve in the steam-pipe of the pumping-engine, which it closes after having reached a certain height. When the cranes, etc., are in operation, the water passes from this cylinder to the pipes actuating the motion of the cranes, and the weighted plunger naturally descends, always keeping up a constant pressure upon the water: in descending, the same causes the throttle-valve to open again, and the water is again pumped in.

ACCURACY OF FIRE.—Firing for accuracy, whether with artillery or small-arms, may involve two entirely separate and distinct things: 1st. The determination of the personal skill of the individual using the weapon. 2d. The determination of the qualities as regards accuracy of the weapon itself. The most common way of determining the relative accuracy of guns is to ascertain their *mean differences of range* and *mean reduced deflection* for a given *mean range*, and compare them—that gun being the most accurate for which these quantities are smallest.

An exact definition of the accuracy of a gun is a matter of no little difficulty. Of two guns fired from the same place, the same number of rounds, at the same target, with their axis in the same direction, that would evidently be the more accurate which planted its shot more nearly together. But it is not always possible to test the practice of guns under precisely similar circumstances; therefore we must seek a definition equally true, but admitting, in addition, more elasticity in its application. Upon reflection, it becomes evident that an absolutely accurate gun is one with which, fired under identical circumstances, the chance or probability of striking the same spot twice amounts to certainty. Adopting the mathematical notion of probability, this will be represented by *unity*—guns less accurate having probabilities represented by fractions. Such a mode, though suggested, has not been accompanied by the requisite tables to render it of general use.

It is easier to determine, from the practice of the gun itself, a rectangle with which there would be an equal chance of any shot from the gun striking or not striking; or, if a given number of shots were fired, half the number might be expected to fall within the area. The accuracies of two guns would be inversely as these rectangles for the same range. This method was proposed by Captain Noble, R.A., who furnished the following formula for application. If a be the length, and b the width of the area or rectangle required, then

$$a = 3.12 \times .8453, \frac{\text{sum of differences of ranges}}{\text{one less than number of ranges}};$$

$$b = 3.12 \times .8453, \frac{\text{sum of reduced deflections}}{\text{one less than number of deflections}}.$$

The relative precision of small-arms is decided by various methods. To determine the *centre of impact*, let the piece be pointed at the centre of a target stationed at the required distance, and fired a certain number of times, and let the positions of the shot-holes, measured in vertical and horizontal directions from the lower left-hand corner of the target, be arranged as in the following table:

No. of Shot.	Distances from lower left-hand corner, in feet.	
	Above.	Right.
1	9	10
2	0	4
3	5	8
	3)14	3)22
	4.67	7.33

The sum of all the vertical distances divided by the number of shots gives the *height* of the centre of impact above the origin. Similarly the sum of all the horizontal distances divided by the number of shots gives the *horizontal distance* from the origin to the centre of impact. Thus from the above table the co-ordinates of the centre of impact are 4.67 and 7.33. The co-ordinates of the centre of the target being 6 each, the centre of impact is 1.33 below and 1.33 to the right of the centre of the target. The co-ordinates of the centre of impact being known, the point itself is known, and its distance from the centre of the target is called the *absolute mean deviation*. This is equal to the square-root of the sum of the squares of its vertical and horizontal distances from the centre of the target. To obtain the mean deviation it is necessary to refer each shot-hole to the centre of impact as a new origin of co-ordinates, and this is done by taking the differences between each tabular distance and the distance of the centre of impact and adding them. The sum of all the distances thus obtained in one direction divided by the number of shots gives the *mean deviation* or *figure of merit*. A shorter rule may be found: for if there are m distances greater, and n distances less than the distance from the origin to the centre of impact, $\bar{x}$, calling a the sum of the greater and b the sum of the less, we may write

$$\frac{a - m\bar{x} + n\bar{x} - b}{m + n} = \frac{a - b + (n - m)\bar{x}}{m + n} = \textit{figure of merit}.$$

In using this formula, due care must be paid to the sign of $(n - m)$. This method might be applied to the fire of cannon by reducing the grazes to an imaginary vertical target, the angles of descent being assumed equal for all shot fired at the same elevation. Applying this formula to the table given above, we get 3.11 feet vertically, 2.22 feet horizontally, for the *mean deviation* or *figure of merit*.

The mean horizontal error is found by adding the horizontal distances by which the balls have missed the centre of the target, and dividing this sum by the number of balls; this quotient indicates how much the average of the balls have missed horizontally the point aimed at. It may be directly and quite readily found by using the formula employed above, substituting for x the horizontal distance of the *centre of the target* from the origin. Similarly the *mean vertical error* may be found, by using the same formula, with the substitution for $\bar{x}$ of the height of the centre of the target above the origin. The result shows evidently by how much the average of the shots have missed vertically. To get the absolute mean error there are two methods. The first is short and simple, and consists in calculating the hypothenuse of a right triangle, in which the other two sides are the mean horizontal and mean vertical errors. The second, which should be called the calculation of the *mean* of the *absolute errors*, consists in measuring for each ball its *absolute error*, a distance from the point aimed at, and to take the mean of these absolute errors by dividing their sum by the number of balls fired. This method is very long, since to have the *absolute error* of each ball it is necessary to square two numbers and then extract the square-root of these sums as the distance of the points struck have been measured upon the vertical and horizontal lines passing through the point aimed at. The results are not exactly the same; the mean of the absolute errors will be greater than the absolute mean error.

ACCUSED.—In a military sense, the designation of one who is arraigned before a Military Court.

A-CHEVAL POSITION.—When troops are arranged so that a river or highway passes through the centre and forms a perpendicular to the front, they are said to be drawn up in *à-cheval position*. Wellington's army at Waterloo was *à-cheval* on the road from Charleroi to Brussels. In cases where a river forms a perpendicular to the front, secure possession of a bridge is necessary; otherwise one half of the troops might be routed, while the remainder stood idly as spectators.

ACIDS.—Chemical compounds distinguished by the property of combining with bases in definite proportions to form salts. The most striking characteristics of acids are a sour taste and the property of reddening vegetable blues. They are also mostly oxidized bodies; and at one time oxygen was thought to be essential to an acid, as the name *oxygen* (the acid-producer) indicates. Subsequent experience has extended the definition. There is an important class of undoubted acids that contain no oxygen; and silex or flint, which, being insoluble, neither tastes sour nor reddens litmus-paper, is held to be an acid because it combines with bases and forms compounds like acknowledged acids. The oxygen acids, which are by far the most numerous class, are formed of elements (sulphur, nitrogen, chromium, etc.) with two or more equivalents of oxygen. The elements that form the strongest acids with oxygen are the non-metallic, and most of them have more than one stage of acid oxidation. Thus sulphur, with two equivalents of oxygen, forms sulphurous acid, symbol SO_2; with three equivalents it forms sulphuric acid, symbol SO_3. Similarly arsenic gives rise to arsenious acid (AsO_3) and arsenic acid (AsO_5). The higher stage of oxidation forms the stronger and more stable acid. All metals, except arsenic, that form acids with oxygen, have also, at a lower stage of oxidation, one or more oxides. To these oxygen acids must be added the organic acids, composed either of carbon and oxygen, as oxalic acid (C_2O_3), or of these two along with hydrogen, as acetic acid ($C_4H_3O_3$) and formic acid (C_2HO_3). There are also acids found in animal fluids or resulting from their decomposition, which contain nitrogen in addition to the three elements above named; such is uric acid ($C_{10}N_4H_4O_6$). The *hydrogen acids* are formed of hydrogen and a radical, either simple or compound. The most important of these, and the type of its class, is hydrochloric or muriatic acid (ClH); others are hydriodic (IH) and hydrocyanic acids (NC_2H). As all acids, however, even oxygen acids, possess acid properties —i.e., combine with bases—only when in combination with water, a new view of the constitution of acids is beginning to prevail, which makes hydrogen the real acidifying element in all acids. Thus, instead of considering vitriol as a compound of sulphuric acid and water (SO_3+HO), the hydrated acid is held to be the real sulphuric acid, and its rational formula to be (SO_4H). It thus becomes analogous to hydrochloric acid (ClH). This view has not only the advantage of bringing all acids into one class, but makes the theory of their combination with bases and of their capacity of saturation uniform and simple.

ACINACES.—An ancient Persian sword, short and straight, and worn, contrary to the Roman fashion, on the right side, or sometimes in front of the body, as shown in the bas-reliefs found at Persepolis. Among the Persian nobility they were frequently made of gold, being worn as a badge of distinction. The *acinaces* was an object of religious worship with the Scythians and others.

ACLIDES.—A kind of missile weapon, in Roman antiquity, with a thong fixed to it whereby it might be drawn back again.

ACOLUTHI.—In military antiquity, *acoluthi* was a title given in the Grecian Empire to the Captain or Commander of the body-guards appointed for the security of the Emperor's Palace.

ACONITE.—A poisonous plant, whose extract was much used by ancient races for poisoning arrows. The virulent *bikh* poison of India, equally fatal in its effects whether introduced into wounds or taken into the stomach, is prepared from the roots of several species. The *aconite ferox* of Nepaul, from which much of it is obtained, has been identified by Drs. Hooker and Thompson with *aconite napellus*. Two other Himalayan species, *aconite palmatum* and *aconite luridum*, are equally employed in its preparation. *Aconite album*, or white-flowered monk's-hood, a native of the Levant, and *aconite lycoctonum*, yellow-flowered monk's-hood, or wolf's-bane, a native of the Alps, are not unfrequent in our flower-gardens.

ACONTIUM.—In Grecian antiquity, a kind of dart or javelin, resembling the Roman *spiculum*.

ACOUSTICS.—The velocity of sound has been determined by ascertaining the time intervening between the flash and report of a gun, as observed at a given distance, and dividing the distance by the time. After many experiments in various countries, Van der Kolk assigned 1091 feet 8 inches per second, with a probable error of 3.7 feet, as the velocity of sound in dry air at 32° Fahr. More recent experiments by the Astronomer Royal at the Cape of Good Hope give 1096 feet. To this velocity may be added 1.11 feet for each degree Fahr. But air is not a perfect gas, and the variations of elastic force caused by a wave of sound passing through it are not uniform; so these measures, though approximately, may not be absolutely, correct. Furthermore, the rapidity of transmission depends upon the loudness of the sound; and Captain Parry found, in the polar regions, that the discharge of a cannon at a distance of 2½ miles was heard perceptibly sooner than the word ordering to fire, which, of course, preceded the discharge. There is also a gradual falling off in the speed of sound; and Regnault determined that a sound decreased in speed by 2.2 feet per second in passing from a distance of 4000 feet to one of 7500 feet. He also found that the velocity depended upon the pitch, the lower notes travelling faster than the higher ones; thus, the fundamental note of a trumpet travels faster than its harmonics. Sound travels faster in liquids than in air, and faster in solids than in liquids. Through iron, sound travels ten and a half times faster than through air. Experiments on telegraph-wire produce almost identical results. Different metals transmit sound in widely different degrees. Wertheim assigned 16,822 for iron and 4030 for lead, at a temperature of 68° Fahr. Except in a few cases, the loudness of a sound is less as the distance increases between the source of the sound and the ear. In an unlimited and uniform medium, the loudness of the sound proceeding from a very small sounding body varies inversely as the square of the distance. But to verify this fact it would be necessary to make a test at a considerable elevation above the earth's surface, the ear and source of sound being separated by air of constant density. As the density of the air diminishes, it would be found that the loudness of a sound at a given distance would decrease. The decay of sound due to this cause is observable in the rarefied air of high mountain regions. De Saussure found that the report of a pistol at a great elevation appeared no louder than would a small cracker at a lower level. But it must be stated that when air-strata of different densities are interposed between the sound and the ear placed at a given distance, the intensity depends only on the density of the air at the source itself; whence it follows that sounds proceeding from the surface of the earth may be heard at equal distances as distinctly by a person in a floating balloon as by one situated on the surface itself; whereas any noise originating in the balloon would be heard at the surface as faintly as if the ear were placed in the rarefied air on a level with the balloon. This was exemplified by Glaisher, the aeronaut, who at an elevation of 20,000 feet heard with great distinctness the whistle of a locomotive passing beneath him. The prolonged roll of thunder, with its manifold varieties, is partly to be ascribed to the reflection of the sound by mountains, clouds, etc., but is mainly due to the comparatively low rate of transmission through air. The explanation will be more easily understood by noting the case of a volley fired by a long line of troops. A person at a given point in the line would hear the sound of the nearest musket first, and of the others in the order of distance, and the effect would be a prolonged roll, concluded by the musket most remote from the hearer, though all were fired at the same instant; and the roll would gradually decrease in loudness. If he stood exactly opposite the centre of the line, the reports from either end would reach him simultaneously and the effect would be more nearly a loud crash. If the soldiers formed a circle, the listener in the centre would hear a single explosion, since the report of every gun would reach his ear at the same instant, and the whole explosion would be equal to that of the sum of all the separate discharges. By varying the form of arranging the troops, corresponding variations in the sound would be produced. Keep in view, then, the fact that flashes of lightning may be regarded as representing lines of troops, at the points and along the ranks of which explosions are generated at the same instant of time; then consider the variety of distance and position relative to the electric discharge of the listener, and we find no difficulty in accounting for the rolling peals of thunder. In a mountainous region this rolling is greatly augmented by reverberations or echoes from the steep declivities.

ACQUEREAUX.—A machine of war, which was much used in the Middle Ages to throw stones.

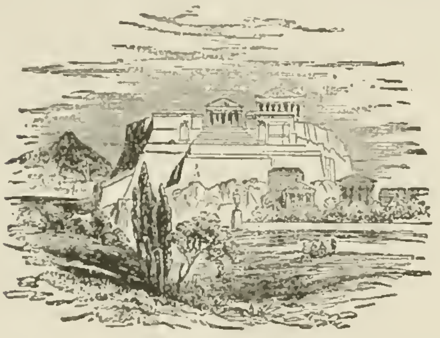
ACQUIT.—To release or set free from an obligation, accusation, guilt, censure, suspicion, or whatever devolves upon a person as a charge or duty; as, the Court *acquits* the accused. This word has also the reflexive signification of to bear or conduct one's self; as, the soldier *acquitted* himself well in battle.

ACQUITTANCE-ROLL.—In the British service, a document in which is shown the monthly settlement of the accounts of a troop, battery, or company, and to which the signature of the soldier is attached, countersigned by the Captain or Officer in Charge.

ACRE—ACRE-FIGHT.—An old duel fought by Warriors with sword and lance on the frontiers of England and Scotland. This dueling was also called *Camp-fight*.

ACROBALISTES.—A name given by the ancients to warlike races, such as the Parthians and Armenians, who shot arrows from a long distance.

ACROPOLIS.—The highest point of a city. Many of the important cities of Greece and Asia Minor were protected by strongholds so named. The acropolis occupied a lofty position, commanding the



Acropolis at Athens.

city and its environs; inaccessible on all sides except one, which had, for the most part, artificial defences. It contained some of the most important public buildings, especially temples, besides affording a last refuge in case of a hostile attack. The acropolis, like the castle of the Middle Ages, had formed the centre or nucleus around which the town gradually grew. Among the most celebrated of ancient times was that of Argos, whose name, Larissa, indicates its Pelasgic origin; that of Messenia, which bore the name of Ithome; that of Thebes, called Cadmea; that of Corinth, known as Acro-Corinthus; but especially that of Athens, which was styled preeminently the Acropolis.

ACTING ASSISTANT SURGEONS.—When it is necessary to employ a private physician in the military service, the Surgeon-General, the Medical Director, or, in emergencies, the Commanding Officer of a detachment may do so by a written contract at a stated compensation. An Acting Assistant Surgeon receives the quarters of an Assistant Surgeon of the rank of First Lieutenant, is furnished with fuel in accordance with the laws and regulations relating to commissioned officers, and when traveling under orders, the same traveling allowances as may be prescribed for commissioned officers of the Army by laws and regulations in force for the time; and when serving west of the Mississippi River, one daily ration in kind. He further receives, at the expiration of his term of service, traveling allowances as aforesaid, *for actual travel only*, to the place of making the contract, provided his contract shall not have been annulled for misconduct or neglect of duty. When a private physician is required to furnish medicines, he is allowed as compensation 25 to 50 per cent on the sum paid for his services, as may be determined by the Surgeon-General. In all cases, contracts are made in quadruplicate, two copies of which are forwarded, through the Medical Director, to the Surgeon-General with the prescribed oath of office; one copy being retained by the officer making the contract, and one copy by the physician contracted with.

The following is the form of Contract with a Private Physician for service as an Acting Assistant Surgeon, U. S. Army:

This contract, entered into this — day of ——, 18—, at —— in the State of ——, between —— ——, of the United States Army, and Dr. —— ——, of ——, in the State of ——, witnesseth: That for the consideration hereinafter mentioned the said Dr. —— —— promises and agrees to perform the duties of a medical officer, agreeably to Army Regulations, at —— [or elsewhere (1*)], [and to furnish the proper medicines (2*)]; and the said —— —— promises and agrees, on behalf of the United States, to pay, or cause to be paid, to the said Dr. —— ——, the sum of —— dollars for each and every month he shall continue to perform the services above stated. When on duty at a post or station where there are public quarters belonging to the United States, he shall receive the quarters in kind allowed by law to an Assistant Surgeon of the rank of First Lieutenant; when on duty at a post or station where there are no public quarters, he shall receive the commutation for quarters allowed by law to an Assistant Surgeon of the rank of First Lieutenant; he shall be furnished with fuel in accordance with the laws and regulations relating to commissioned officers, and when traveling under orders, the same traveling allowances prescribed for commissioned officers of the Army by laws and regulations in force for the time; and when serving west of the Mississippi River he shall receive one daily ration in kind. [And if the said Dr. —— —— shall be required to furnish his medicines, he shall be compensated therefor at the rate of —— per cent on his monthly pay, to be determined by the Surgeon-General (3*).] And it is furthermore agreed, that at the expiration of his term of service, the said Dr. —— —— shall receive traveling allowances, as aforesaid, for actual travel only, to the place of making the contract; provided said contract is not annulled for misconduct or neglect of duty, in which case no traveling allowances will be furnished. All of which shall be his full compensation, and in lieu of all allowances and emoluments. This contract to continue at least —— if not sooner terminated by the General commanding the Military Division or Department, the Medical Director, or the Surgeon-General.

It is furthermore expressly agreed and understood that, in conformity to the requirements of Section 3711 of the Revised Statutes, no member of, or delegate to, Congress shall be admitted to any share or part in this contract, or to any benefit to arise therefrom.

In this contract (1*) (2*) (3*) ha— been stricken out.

—— —— [Seal.]
—— —— [Seal.]

Signed, sealed, and delivered in the presence of

—— ——

The accounts of Contract Physicians are paid by Paymasters, and are made out in the ordinary form of an officer's pay-account, vouched for by a certificate thereon by the Commanding Officer that it is correct and according to contract, and that the services have been duly rendered, which certificate he does not make unless the contract has been approved by the Medical Director of the Department or by the Surgeon-General. The payments are made under the same rules that govern in the payment of officers at the same station. See *Contract Surgeons*.

ACTING SIGNAL OFFICER.—An officer temporarily serving as a Signal Officer. When an officer is detached from his regiment for Signal duty, he immediately reports for orders to the Chief Signal Officer of the Army, and thereafter is relieved from such detail only by orders from the Adjutant-General of the Army. When it is necessary to employ officers on Signal duty in the field, they may be temporarily assigned by orders of the Department Commander, but will not be part of the Department Staff. For this purpose officers who have been regularly instructed by the Chief Signal Officer of the Army are selected if practicable. The senior Acting Signal Officer of any command is the Chief of the Signal Parties serving in that command. Orders and instructions affecting their duties are transmitted through him. He is responsible that his officers and men are fully instructed and properly perform their duties. He keeps himself informed of the position of the Army and of the enemy, and, under the instruction of the General Commanding, establishes his stations to the greatest advantage. He takes care, by inspections and timely requisitions, that his parties are well supplied with equipments. He makes reports of his operations in the field from time to time to the General Commanding, and, with his assent, forwards certified copies of these reports to the Chief Signal Officer of the Army. He makes the usual returns and monthly statements, and at the end of each month a report to the Chief Signal Officer of the Army of the condition of his party, and all matters pertaining to its duties.

ACTINOMETER.—An instrument used in the laboratory and in powder-factories to measure the heat of the sun's rays; at first a common thermometer, the bulb blackened with nitrate of silver; then one with a large bulb filled with blue solution of ammonia and sulphate of copper, enclosed in a box with a plate-glass top, the expansion of the liquid to indicate the amount of heat. Prof. John W. Draper of New York next discovered that equal volumes of chlorine and hydrogen form chlor-hydric acid in direct proportion to the actinic intensity of the light and the time of exposure. Subsequently Bunsen and Roscoe hit upon the same plan. There are other actinic reactions; as, in a solution of chloride of gold and oxalic acid, the gold precipitates on exposure to actinic rays.

ACTION.—1. An engagement or battle between opposing forces; or some memorable act done by an officer, soldier, or detachment. The term is commonly used in artillery exercise when guns are brought into or change position with the view of attacking an opposing object. 2. In its large and general sense, a judicial proceeding before a competent tribunal for the attainment of justice; and in this sense it is applied to procedure, whether *criminal* or *civil*. In its more limited acceptation, it is used to signify proceedings in the *civil* courts, where it means the form prescribed by law for the recovery of a right or what is one's due. No action can be maintained by a citizen against a government without the government's express consent; except in rare special cases no suit can be brought by a citizen against the United States; relief must be sought by petition or in the Court of Claims. State Courts do not ordinarily contest acts of foreign states or sovereigns for anything done or omitted in their public character. Here negotiation takes the place of suit. Modern statutes have much simplified proceedings under this title, and many old forms have been abandoned. In New York an effort has been made to avoid all distinctive forms; there every other than a criminal is a civil action, having no other specific name; the design of the code being to give by this action every kind of relief which can be sought in civil causes.

ACTIVE SERVICE.—Duty against an enemy; operations in his presence. At present *active service* denotes serving on full pay, on the active list, in contradistinction to those who are virtually retired, and placed on the retired list.

ACTO—ACTON.—A kind of defensive tunic, made of quilted leather or other strong material, formerly worn under the outer dress and even under a coat of mail.

ACT OF GRACE.—In Great Britain, an Act of Parliament for a general and free pardon to deserters from the service and others.

ACTS OF HOSTILITY.—Proceedings of a diplomatic, commercial, or military character, involving a state of war between two or more nations. This was exemplified in 1870 in the altercation between Count Benedetti, the French ambassador, at the Court of Berlin, and the King of Prussia at the Kursaal of Ems. This is an instance of the first-named act of hostility. The second is shown in the case of the embargo laid on British shipping by the first Napoleon after the peace of Amiens in 1803. The third consists in the invasion of a friendly territory or firing on armed vessels of a friendly nation. A further act of hostility of a civil character is the forcible detention of the subjects of a friendly nation, which was exemplified in the seizing of non-belligerent British subjects residing in France in 1803.

ACTUARIUS.—A name given by the Romans to officers charged with the supplying of provisions to troops.

ADACTED.—A term applied to stakes or piles driven into the earth by large malls shod with iron, as in securing ramparts or pontons.

ADAMS BREECH-LOADER.—The distinguishing feature of this invention is the use and application of a piston for the purpose of loading, cleaning, and cooling a cannon *from* the breech. A rod passes through the breech or rear end of the gun and is fastened to a head or metallic piston, the circumference of which is equal to the bore of the cannon. Water is admitted at the breech to fill the bore when the piston is forced towards the muzzle. After the bore is cleaned and cooled, the new cartridge is attached to the piston and drawn back to the breech, in which condition the gun is loaded and ready to be again discharged.

ADAMS CUTTER.—This invention was made while the inventor was endeavoring to make two cutters, having exactly the same dimensions, for the Rodman pressure-gauge, having as a model a pressure-gauge designed for use with muskets. The knife-edge of this model was of the usual pyramidal form of the Rodman Cutter, and was .78 inch in length. Mr. Adams found that it was a mechanical impossibility to so file the faces of this pyramid as to have the two cutting or indenting edges identical in form and dimensions. He accordingly conceived the idea of turning a beveled edge with a circular profile upon the perimeter of a steel disk, as this could be accurately done in a lathe or mill, thus securing the perfect agreement of all cutters taken from that disk, and at the same time diminishing both the cost and time of fabrication. He took the Rodman Cutter above mentioned, and found by trial a circle which would pass through the three angular points of the edge. This circle, whose diameter he found to be 2.88 inches, he assumed as the one which should form the cutting edge of the new series of cutters to be fabricated. The steel disk was .233 inch thick. It was pierced with a central hole 1 inch in diameter for convenience of adjustment to an arbor of a lathe or mill. The bevels upon the two sides were equal. Hence the cutting edge itself is an arc of a circle with a diameter equal to 2.88 inches, and is formed by the intersection of two right cones, turned base to base (bases circular), and having a common axis. This makes the *bottom* of the cut, or indentation in the copper block, an arc of a circle, and the limiting lines of the *same* indentation upon the surface of the block arcs of two equal hyperbolas. The *cutter-block* is rectangular in shape, 1.18 inches long, .74 inch wide, and .74 inch thick. A groove is planed in one of the longer sides .2 inch deep, and sufficiently wide to receive the indenting edge. On the opposite side is drilled a hole .4 inch deep and .5 inch in diameter, for the reception of the larger end of the piston. In the bottom of this hole a smaller one is countersunk for a small screw which projects into the cutter-groove and serves to hold the indenting segment in position after insertion. This segment projects .3 inch from the cutter-block and is engaged .2 inch in that block. See *Benton Dynamometer*, *Circular Cutter*, and *Pressure-gauge*.

ADAPTER.—A gun-metal bush, used when shells having the obsolete Moorsom-gauge fuse-hole are fired with fuses which are not adapted to this fuse-hole. The pattern adapter now in use is known as the "G.S. adapter," which screws into the Moorsom fuse-hole. There are two distinct adapters, one for spherical shell, the other for rifled shell. Up to the year 1867 all shells for the larger rifled ordnance down to the 40-pdr. L.S. and the 20 pdr. S.S. common shell were made with the Moorsom or naval fuse-hole. Since then all new shells have been tapped with what is termed the G.S.-gauge fuse-hole, and shells already in service which have not this sized hole receive the G.S. adapter. The shape of the inside of the adapter is conical, the outside cylindrical.

ADARGA.—A Spanish-Moorish targe, made of supple leather, and 30 by 38 inches. It was used about the close of the sixteenth century.

ADDISCOMBE SEMINARY.—An Institution near Croydon, Surrey, England, for the education of young gentlemen intended for the military service of the East India Company. Closed in 1861. See *Cadet*.

ADIT.—A nearly horizontal passage opened for the purpose of draining a mine; it serves incidentally to explore the rock through which it passes; when filled with water, often used as a canal by which the products of the mine may be transported. Water raised from a depth greater than that reached by the adit is discharged through it, saving the cost of raising still farther to the top of the shaft. An adit opens in Cornwall at the level of the sea, and extends inland about 30 miles, draining the district of Gwennap. It meets some shafts at the depth of 400 feet. The "Ernest August" adit in the Hartz, completed in 1864, is 13 miles long. The "Joseph II." adit at Schemnitz, in Hungary, is 12 feet high, 10 feet wide, extends 12 miles to the valley of the Gran, and is used as a canal and a railway.

ADJOURN.—To suspend business for a time, as from one day to another; said of Military Courts. *Adjournment without delay* (*sine die*), indefinite postponement.

ADJUTANT.—As the derivation of the word implies (*adjuvare*, to help), *Adjutant* is the title of a Regimental Staff-officer who assists the Commanding Officer of a garrison or regiment in all the details of duty. He receives orders, and promulgates them to the several companies; he inspects escorts and guards before proceeding on their duty; attends to the drill of recruits, is accountable for the keeping of the regimental books, and ought to note every infraction of established rules. He is accountable to the Commanding Officer for the correctness of the regimental books, and is bound to bring to his notice all infraction of rules or orders. From the foregoing it will be seen that the duties of an Adjutant are unremitting. Agreeably to the Queen's Regulations, no officer is eligible for the appointment of Adjutant in the British service who has not obtained a first-class certificate at the School of Musketry, unless the regiment is on service abroad, and even then under certain restrictions. An Adjutant, generally holding the rank of Captain, is appointed to each brigade of artillery, to divisions of artillery of two or more batteries detached from their headquarters, and as his duties are somewhat different to those of a line or cavalry regiment, it may not be out of place to detail them. The duties, then, of an artillery brigade Adjutant are, to a great extent, confined to his office, as the several batteries composing his brigade are often stationed far from their headquarters. In his office are kept the books and records of the brigade; from it he circulates to detached batteries all orders received from the Commanding Officer and higher authority. He prepares correspondence on questions relating to the claims, services, enlistments, discharges, etc., of the men of his brigade; and when acting as the Staff-officer of the Royal Artillery in the division, he has to prepare all local returns which are submitted to the General Officer Commanding. He has, besides, to attend to the usual duties of the guards, prisoners, courts-martial, etc. As regards drill, Commanding Officers of batteries carry out or work their own drills independently, and recruits are trained at Woolwich, or at the centers of sub-divisions of districts. The Adjutant is responsible to the Commanding Officer for the state of exactness with which the regimental books are kept, and for the correctness of the duty rosters. He is to give his attention to everything appertaining to the discipline of his brigade, bringing to the notice of the Commanding Officer any irregularity or deviation from the established rules and regulations. In fact, nothing should escape his attention and observation.

ADJUTANT-GENERAL.—The principal organ of the Commander of an Army in publishing orders. The same organ of the Commander of a Division, Brigade, Geographical Division, or Department, is styled Assistant Adjutant-General. In the United States service, the main duties of the office of Adjutant-General are to publish orders, write out and issue instructions, receive and care for returns, keep account of the state of the army and the position of forces, regulate details of the service, carry on correspondence, preserve order; and in active war to establish camps, supervise hospitals, muster and inspect troops, form parades and line of battle, and care for prisoners and deserters. In the British service the Adjutant-General keeps an account of the strength of each regiment, distributes the orders of the day to the Brigade-Majors, and sees the troops drawn up for action. The *Adjutant-General of the Forces* is an officer of high rank at the Horse-Guards. To him all communications are addressed regarding leave of absence, discharging, recruiting, etc. Besides the Adjutant-General at the Horse-Guards, there are Deputy and Assistant Adjutants-General for special military districts.

ADJUTANT-GENERAL'S DEPARTMENT. — All General Orders which emanate from the Headquarters of the Army; the orders of detail, of instruction, of movement, and all general regulations for the Army, are communicated to the troops through the Office of the Adjutant-General. The record of all military appointments, promotions, resignations, deaths, and other casualties; the registry of all commissioned officers; the filling up and distribution of their commissions, and the preparation and issue of the Army Register, pertain to the Adjutant-General's Office. This Office is the repository for the records of the War Department which relate to the *personnel* of the military establishment, and to the military history of every commissioned officer and soldier of the Regular and Volunteer forces in the service of the United States. In this office the recruiting service is conducted; the names of all enlisted soldiers are enrolled, their enlistments and descriptive lists are entered, and all deaths, discharges, desertions, etc., are recorded; the general returns of the Army are consolidated; the monthly returns of regiments and posts and the muster-rolls of companies are preserved, the inventories of the effects of deceased officers and soldiers are entered, and the annual returns of the militia, required by law to be submitted to Congress, are prepared. The Adjutant-General's Department, as organized in the United States service, consists of one Adjutant-General, with the rank of Brigadier-General; two Assistant Adjutant-Generals, with the rank of Colonel, four Lieutenant-Colonels; and ten Majors; also, about four hundred enlisted clerks and messengers. The officers are generally on duty with General Officers who command Corps, Divisions, Departments, etc. The appointments to the lowest grade are selected from the Captains of the Army.

ADMINISTRATION.—The aim of a system of administration is to secure the performance of public duties, either directly, ministerially, or through the intervention of sub-agents. It is exercised over individuals or things, in civil matters, in courts of law, in political bodies, in the army and in the navy, and in general in all *financial* matters of government. Administration consists in establishing the ways and means of public receipts and expenditures; in watching over such employments; in the collection, care, and distribution of material and money; and in rendering and auditing accounts of such employments. Army Administration also embraces in war the means by which an army is supported in foreign countries by a General in campaign, when without regular supplies, without resorting to pillage. The wars of the French Revolution brought into use REQUISITIONS, a moderate kind of marauding, weighing more heavily upon countries than upon individuals. Requisitions are, however, an uncertain and unequal means of supply, and only enable an army to live from hand to mouth, and although practicable in offensive wars, are only justifiable in rapid movements, where time does not admit the employment of more certain means of supply. The system is less odious than pillage. Bonaparte skillfully adopted another method, in harmony with the spirit of wars of invasion, and also more reliable as a means of support. He substituted himself in place of the supreme authorities of the invaded country, and exacted *pecuniary contributions*, paying, or promising to pay, for all provisions and other supplies needed for his army. Some writers think that even this modified system can only succeed in gigantic operations, where an army upon a new soil successively gives repose to that previously occupied. Such a system was, however, well executed by Marshal Suchet in Spain, and a similar system was also matured and published in orders by General Scott while in Mexico. A treaty of peace, however, soon after was made, which put an end to military operations, and the system was therefore only partially executed. But with a sufficient army in a fertile country, the experience of the world has shown that if the inhabitants are protected from injuries, they will very generally sell to the best paymasters. It is therefore the interest of an invading army not to interfere with the ordinary avocations of citizens, and such is the modern usage. Bonaparte thought that an entire revolution in the habits and education of the soldier, and perhaps also in those of the officers, was essential to the formation of a veritable self-subsisting army. Such an army (he said) cannot exist with present ovens, magazines, administration, wagons, etc., etc. Such an army will exist when, in imitation of the Romans, the soldier shall receive his corn, shall personally carry his mill and cooking utensils, cook his own bread, etc., etc., and when the present frightful paper administration has been dispensed with. He added that he had meditated upon all those changes, but a period of profound peace was necessary to put them in practice. If he had been constrained to keep a large army in peace, he would have employed it upon the public works, and given it an organization, a dress, and a mode of subsistence altogether special. If such a scheme be practicable, no approach to it yet exists. The French have made some progress in developing a system of administration suited to a large army, but hardly a step in the direction pointed out by Napoleon. The French administrative service is a powerful means of moving armies in unforeseen emergencies. Its foresight provides resources, and the adversary soonest ready has the greatest chance of success. Not a century since, the French Government required six months' preparation before an army could move; now, in the language of General Lamarque, "The cannon is loaded, and the blow may be given at the same moment as the manifesto, and, if necessary, the blow may precede it." Ordinary army administration consists in the organization and other means by which various administrative duties are performed, necessary to provide for the wants of troops, and for all the foreseen demands of a state of war, including labor and the supplies for garrisons, sieges, etc. Such duties embrace subsistence-magazines, daily rations, forage, dress, encampments, barracks, hospitals, transportation, etc., etc., the administrative duties of Engineers, and of the Ordnance Department, estimates, accountability, payments, recruiting, and in general the receipt and proper application of money. The Secretary of War, under the orders of the President, is the head of military administration in the United States. The object of such administration is to provide, through the resources placed by law at his disposition, for the constant wants, regular or accidental, of all who compose the army. Good administration embraces a foreknowledge of wants, as well as the creation, operation, and watchfulness of the ways and means necessary to satisfy them; the payment of expenses, and the settlement of accounts. Army administration is divided into several branches determined by law. These different branches constitute the administrative service of an army, the operations of which should be so regulated that the Secretary of War will be always informed of the condition of each, and be able to exercise, subordinate to law, a complete financial control over each. The Adjutant-General of the army and the heads of administrative corps have each been assigned a bureau in the War Department, under the direction of the Secretary of War, for the management of the administrative duties with which they have been respectively charged. Administration and Command are distinct. Administration is controlled by the head of an Executive Department of the Government, under the orders of the President, by means of legally-appointed administrative agents, with or without rank, while Command, or the discipline, military control, and direction of military service of officers and soldiers, can be legally exercised only by the military hierarchy, at the head of which is the constitutional Commander-in-Chief of the army, navy, and militia, followed by the Commander of the Army, and other military grades created by Congress.

ADMISSIONS.—In a military sense, the Judge-Advocate is authorized, when he sees proper, to admit what a prisoner expects to prove by absent witnesses.

ADOBES.—Unburnt bricks made from earth of a loamy character containing about two thirds fine sand mixed intimately with one third or less of clayey dust or sand. The adobe under the action of the sun becomes a compact mass. Upon the Indian frontiers in New Mexico, in Mexico, and in Central America, adobe houses and adobe defences against the Indians are common structures. An adobe eighteen inches long, nine inches wide, and four inches thick is the best average size for moulding and for building. They are sometimes made sixteen inches long and twelve inches wide; in such cases they are all laid as *headers;* but with the eighteen-inch adobe they afford the means of binding the wall strongly by alternating headers and stretchers, as in brick-laying. In the hot spring and summer suns two or three days uninterrupted drying is sufficient at the first; the adobes are then carefully turned up on edge, so as to expose the under or still wet face to the southern and western sunshine. They should be left in this position from a week to fifteen days to dry thoroughly, when, if not wanted for immediate use, they may be stacked on edge and covered from the weather. Houses in New Mexico are seldom built over one story high. This enables the builder to place on the roof-covering at once, if necessary. But in all cases intervals in the work must be allowed, or the house will not only be unsafe, but, if immediately occupied, damp and disagreeable. The inside plastering with mud is most frequently done before the roof is covered in, so as to dry with the wall. If the wall must be left unfinished through the fall rains or the winter, the top of it is covered with a bushy weed called *cachanilla*, and this is covered with earth, to exclude water and protect it till the ensuing year. If door and window frames are at hand, the Mexicans prefer to put them in as they build; but oftener they leave gaps for doors and windows, unfilled with the frames, till the whole is finished. The adobes are laid with mud mortar made from the earth at the base of the wall; the holes thus formed are readily filled again with the rubbish from the house when completed. When the wall is ready to receive the roof-covering, heavy joists are laid, about two feet apart, on the top of the walls, strong enough to bear near a foot of earth all over the roof; the joists, as they rest upon the wall, are supported upon boards, or plates as they are called, to distribute the weight of the roof and prevent the joists from crushing into the walls. Across the joists, and over the whole roof, averaging about two inches in diameter, poles are now placed, the largest on the highest side of the roof to begin the slope, and on this is placed a close covering of the *cachanilla*, which is aromatic and keeps out bugs; it is evergreen, and a plant of the most suitable length to fill the interstices in the poles. Small willow brush is often used in the absence of *cachanilla*. The earth-covering of the roof is now put on, extending all round the roof to the parapet above the joists, which is only one half the width of the wall below; this brings the dirt roof to cover over one half the width or thickness of the wall, by which leaks in the room below are prevented. An adobe house, if well secured, is warmer in winter and cooler in summer than one of wood or brick. The brick is cold and damp; the adobe is dry and a much worse conductor of heat—no furrowing or lathing is necessary—and the rough inside can be whitewashed or slapped with plaster. The durability of adobe walls is extraordinary. The Pecos Church, not far from Santa Fé, is more than one hundred years old; its mud walls (adobe) are as firm to this day as a rock, and they cannot be less than fifty feet high.

ADVANCE—ADVANCED.—Any portion of an army which is in front of the rest. The term is figuratively applied to the promotion of officers and soldiers.

ADVANCED COVERED-WAY.—A *terre plein* on the exterior of the advanced ditch, similar to the first covered-way.

ADVANCED DITCH.—An excavation beyond the glacis of the enceinte, having its surface on the prolongation of that slope, that an enemy may find no shelter when in the ditch.

ADVANCED-GUARD.—To keep an enemy in ignorance of the state of our forces and the character of our position is one of the most indispensable duties in war. It is in this way that we oblige him to take every possible precaution in advancing; forcing him to feel his way, step by step, and to avoid risking his own safety in hazarding those bold and rapid movements which, when made against a feeble or an unprepared enemy, lead to the most brilliant results. This object is effected by placing between the position occupied by the main force and the presumed direction of the enemy a body detached from the main force, but acting always with reference to it, termed an *Advanced-Guard*. This term is used for any body of troops so separated from the main body, whatever its strength and composition, and whether the troops be in position or on a march. For a large force the advanced-guard is necessarily composed of troops of all arms; its strength being proportioned to that of the main force; the more or less resistance of an independent character it may be required to make; and the greater or less extent it may be found necessary to embrace, by its advanced-posts, on the front and flanks, to watch and anticipate every movement of the enemy. The proportion of the advanced-guard to the main body may vary from a third to a fifth of the total force. In armies of some strength, or large *corps d'armée*, particularly where the nature of the country requires a wide development of advanced-posts, the larger proportion is demanded; as at least one third or even one half of its strength will be required for the advanced-post service. In a small force of two or three thousand men, one fifth will usually be all that can be well spared for the same purposes. Our purpose, in all cases, should be to keep the enemy in a state of uncertainty as to our actual force and movements; and this can be effected only by keeping constantly between him and our main body a force of sufficient strength to offer an obstinate resistance, if necessary, to every attempt he may openly make to gain information; and even to act offensively against him, when occasion offers, so as to keep him in doubt as to the actual character and number of the troops before him; the old military axiom being always kept in mind, that "*a sword opportunely drawn frequently keeps another back in its scabbard.*" In all defensive positions the advanced-guard and its advanced-posts should retire slowly but circumspectly, so that the main body may have time to take all its defensive measures. In the offensive, the attack of the advanced-guard should be decided and vigorous; pressing upon the enemy at every point; and leaving nothing undone to demoralize him, by the confusion which so often follows from an impetuous onset. Whilst in position the advanced-guard should take advantage of the natural or other obstacles on its front and flanks which are within supporting distance; to strengthen itself, and gain supports for its advanced-posts. In this way its means of resistance, whether acting offensively or otherwise, may be greatly augmented. Ground of this character taken up by the troops should not be abandoned without very cogent reasons for it; since, should circumstances bring about a forward movement, it might cost more to regain what was given up than to have maintained it obstinately at first. The ground to be taken up by an advanced-guard and embraced within its advanced-posts should be carefully chosen. To take position where the movements of the enemy can be well watched, whilst our own troops are kept concealed and not liable to a sudden attack either in front or flank, are the *desiderata* in such cases. If, in following this guide, it should lead to a development of advanced-posts which would be too weak at any point for a tolerable resistance, there remains but the alternative to retire slowly before the enemy,—taking care that he do not slip behind the outposts and their supports,—upon some central point to the rear, where the advanced-posts, united to the troops in reserve, may make a good stand, and from which, if the chances are favorable, they may advance upon the enemy and make him pay dearly for his temerity. In all affairs of advanced-guards great circumspection is to be shown, both by the officer in command of the advanced-guard, in throwing forward fresh troops to strengthen a point assailed, as well as on the part of the General-in-Chief, in sustaining the advanced-guard by weakening his main body. These are points that can only be decided on the spot. The safer rule, in all cases, is not to weaken the main defence, or main attack, by detaching from it to support a feeble point. If the force engaged, under such circumstances, does not suffice for its own defence, it is best for it to fall back in time and, taking position with the main body, endeavor, by their combined efforts, to turn the scales of victory in their favor. The duties of advanced-guards being so much more frequently to feel and occupy an enemy, preparatory to some decisive blow by the main body, than to engage him with a view to follow up any advantage gained, it follows, as a matter of course, that they should be composed of the most efficient and active light troops at the General's disposal. Such troops, in the hands of a bold, energetic, but prudent leader, will be the right arm of an army: prompt on all occasions; never taken at fault, they keep the enemy constantly occupied; harass him with fatiguing precautions to secure his flanks and rear; whilst their own force is kept relieved from these annoyances, and always fresh for any great emergency.

ADVANCED-LUNETTES.—Works resembling bastions or ravelins, having faces or flanks. They are formed upon or beyond the glacis.

ADVANCED-POSTS.—Positions taken up by a force in advance of the main body of an army, and in such a situation that they shall be within easy communication of it and of one another. The duties of the advanced-posts are the same whether the troops are stationary or in movement. They are: 1. To keep a good lookout for the enemy, and when in his immediate presence to take all means to be accurately informed of his strength, position, and movements; 2. Should the enemy advance, to hold him in check long enough to give the main body ample time to be prepared for his attack. By a faithful discharge of these duties, the whole army can, at all times and under all circumstances, be kept in a state of readiness for action without subjecting the soldier to any fatigue beyond the ordinary physical endurance of a well-developed manhood; as but a small portion, comparatively, of the force present is required to watch over the safety of the rest, and can therefore be frequently relieved, so that every one may have time sufficient for the repose demanded after extraordinary exertions. The object being to secure the front and flanks of the position occupied by the main body from any attempt either to reconnoiter or attack it, the detachments which form the advanced-posts must be so distributed as to embrace all the avenues by which the enemy can approach the position. The system adopted, in most services, to effect this object consists of two or three concentric lines of posts, disposed in a *fan-shaped* order. The exterior line, which forms the *Outposts*, embraces a wide circumference, and by means of a chain of *Sentinels*, posted in advance, prevents any one from penetrating to the rear between the posts without being seen. The second line, which is one of *Grand-Guards*, embraces a narrower circumference than the line of outposts, occupying the more important avenues from the outposts to the interior, so as to be in a position to support the outposts in case of necessity, and to receive them if driven in. The interior line consists of several strong detachments, termed *Pickets*, posted upon the main avenues to the position. They serve as supports to the two exterior lines, upon which they rally if forced to retire before the enemy. Besides these dispositions for security, *Patrols* are kept up between the line of posts, to keep the one informed of the state of the other; and also between the outposts and chain of sentinels, to see that the duties of the latter are well performed; and to search any ground not brought well under the eyes of the sentinels. The whole, in this way, forms a connected system for observing the enemy and for mutual support in case of attack. The ground taken up by the advanced-posts will depend on the capabilities which its natural features offer for defence; on the number and character of the approaches it presents to an enemy for attacking the front or flanks of the position occupied by the main body; and upon the facilities it may afford for communication between the posts. See *Outposts*.

ADVANCED-WORKS.—Works placed beyond the covered-ways of the enceinte and its outworks, but connected with them in a general system of defence, are termed *advanced* and *detached works*. The term *advanced-works* is applied to such works as, placed beyond the outworks, are still under the fire of either the enceinte or the outworks, so that the ground in advance of them will be swept by this fire; their ditches flanked by it; and their interior so exposed to it that, if the work were seized by an open assault, the assailant could be driven from it by this fire. Advanced-works are placed in positions which the assailant must necessarily make himself master of before he can approach nearer to the main work; or on points which overlook ground that cannot be swept by the fire of the enceinte; and sometimes on points which, inaccessible to the assailant, give good position from which a flank-fire can be brought to bear upon ground over which the assailant will be obliged to make his approaches. Restricted to these purposes, an advanced-work may be of great value in prolonging the defence; and every precaution should be taken to secure it from a surprise, and to give its garrison a safe means of communication with the main work upon which they can retire when forced to abandon their work. When there are full and strong garrisons, advanced-works, by judicious combination with those in their rear, may greatly enlarge the field of action of the garrison, by keeping the assailant at a distance and annoying him by frequent sorties in large bodies. See *Detached-Works*.

ADVANTAGE-GROUND.—That ground which affords the greatest facility for annoyance or resistance.

ADVERSARY.—A term generally applied to an enemy, but strictly an opponent in single combat.

ADVISING TO DESERT.—A crime punishable with death or otherwise as a Court-Martial may direct. The Articles of War provide that any officer or soldier who advises or persuades any other officer or soldier to desert the service of the United States shall in time of war suffer death or such other punishment as a Court-Martial may direct, and in time of peace any punishment excepting death which a Court-Martial may direct.

ADYNATI.—An ancient name for invalid soldiers receiving pensions from the public treasury.

AEEN.—A tree which grows in the Madras Presidency at Coimbatore. It is very hard, heavy, and durable under water. It is said to be found in all the teak-forests of India and Burmah. A cubic foot of unseasoned wood weighs from seventy to seventy-three pounds. It is used in the Bombay Gun-carriage Agency for shafts, handspikes, and yokes.

ÆGIDE.—A name, according to Homer, for a protecting covering wound around the left arm in the absence of a shield; used by Jupiter, Minerva, and Apollo.

ÆGIS.—The shield of Jupiter, which had been fashioned by Hephæstus (Vulcan). When Jupiter was angry, he waved and shook the ægis, making a sound like that of a tempest, by which the nations were overawed. The ægis was the symbol of divine protection, and became, in course of time, the exclusive attribute of Jupiter and Minerva.

ÆNEATORES.—In military antiquity, the musicians in an army, including those who sounded the trumpets, horns, etc.

ÆRARIUM MILITAIRE.—The war-treasury of Rome, founded by Augustus. In addition to other revenues, the one-hundredth part of all merchandise sold in Rome was paid into it.

ÆRO.—A basket used by the Roman soldiers for carrying earth to construct fortifications.

AÈRODYNAMICS.—That branch of science which treats of air and other gases in motion. It examines first the phenomena of air issuing from a vessel, which correspond in many respects with those of water. Much depends, as in the case of water, upon the nature of the orifice, whether a mere hole in the side of the vessel, or a tube or adjutage. Another subject of aerodynamics is the motion of air in long tubes, where the resistance of friction, etc., has to be ascertained. That resistance is found to be nearly in proportion to the square of the velocity, to the length of the tube, and inversely to its width. Aerodynamics examines also the velocity of air rushing into a vacuum, of wind, etc. The instrument used for the latter purpose is called an anemometer. Air is found to rush into a void space at the rate of from 1300 to 1400 feet per second. One of the most important inquiries in aerodynamics is the resistance offered to a body moving in air, or—which is the same thing—the pressure exerted by air in motion upon a body at rest. The law may be stated, with sufficient accuracy for practical purposes, as follows: *The resistance or pressure is proportional to the square of the velocity.* We might conclude from reason, without experiment, that such would be the case; for if one body is moving through the air four times faster than another of the same size, not only will it encounter four times as many particles of air, but it will give each of them four times as great an impulse or shock, and thus encounter 4×4, or sixteen times as much resistance. This resistance is greatly increased by another circumstance, especially with great velocities. The air in front of the moving body becomes accumulated or condensed, and a partial or even entire vacuum is formed behind it. With a velocity of 1700 feet per second, for instance, the resistance is found to be about three times as great as the simple law of the square of the velocity would give. By the operation of these laws of resistance, a heavy body let fall with a parachute attached to it, comes, after a certain time, to move with a velocity approaching more and more nearly to a uniform motion.

AEROKLINOSCOPE.—An instrument to show differences of barometric pressure at remote stations. It consists of a vertical axis 30 feet high, turning on a pivot, carrying at the top a horizontal arm, of which the inclination can be varied according to the difference of barometric pressure at different sides of the station; the amount of dip being indicated by a sliding rod held in position by graded notches at the lower part of the axis, each notch corresponding with one millimeter in pressure. It is used in the weather service.

AEROSTATICS.—That branch of science which treats of the equilibrium and pressure of air and other gases, and of the methods of measuring it by the barometer and other instruments. The expansive force or pressure of atmospheric air varies with time and place. In a medium condition of the atmosphere, and near the sea-level, barometrical observations give the pressure or weight equal to that of a column of mercury 30 inches high, or of a column of water about 34 feet high. This makes the mean pressure of the atmosphere nearly 15 lbs. on every square inch. This mean pressure of the atmosphere is generally taken as the unit or measure of expansive or elastic forces generally: any particular pressure is said to be equal to so many atmospheres. Aerostatics also investigates the phenomena of the compression of gases; in other words, the relation between the elasticity and the density or volume of a gas. According to the law of Mariotte, the expansive force of one and the same body of gas is proportional to its density; or, which is the same thing, the expansive force of a body of gas under different degrees of compression varies inversely as the space which it occupies. If its elastic force, at one stage, be measured by 50 lbs., when compressed into half the space that force will be 100 lbs. Connected with this is the investigation of the variation of density and pressure in the several vertical strata of the atmosphere. It is obvious that the weight of the atmosphere must diminish as we ascend, as part of it is left below; and it results from Mariotte's law that, at different distances from the earth's surface, increasing in arithmetical progression, the atmospheric pressure diminishes in geometrical progression. This principle furnishes the means of measuring heights by the barometer. The elastic force of air and other gases is very much increased by heat, and consequently, when allowed, they expand. It is found that a rise of temperature of 1° of Fahrenheit causes any gas to expand $\frac{1}{480}$ of its own bulk; and this expansion is uniform. If adding 10° to the temperature of a body of gas increases its bulk 3 cubic inches, an addition of 20° will give an increase of 6 inches; of 50°, 15 inches; and so on. This law was discovered by Gay-Lussac, and has been verified by subsequent investigators. Both it, however, and that of Mariotte, can be looked upon as only nearly true, and that within certain limits.

ÆRUMNULA.—A wooden pole or fork, introduced among the Romans by Consul Marius. Each soldier was provided with one of these poles, which had attached thereto a saw, hatchet, a sack of wheat, and baggage. The soldier was compelled to carry it on a march.

AFABUAR.—A color-bearer of the ancient Icelanders. Every war-vessel had one of these officers aboard, who commanded the soldiers. The Afabuars were selected for this duty for their bravery.

AFFAIR.—An action or engagement not of sufficient magnitude to be termed a battle, but usually of more importance than a skirmish; as, the affair of outpost, or the affair of rear-guard.

AFFAMER.—To besiege a place so closely as to starve the garrison and inhabitants.

AFFIDAVIT.—In military law, an oath duly subscribed before any person authorized to administer it. In the United States, Judges, Justices, Notaries, Commissioners, and Commissioned Officers have authority of law to take affidavits. All the States appoint Commissioners in other States (residents of such other) to exercise the power. By New York law, affidavits may be taken anywhere for use in New York, if the person taking is authorized at the time and place to do so. Generally the authority of foreign officials to take affidavits must be certified or verified in court. When a Judge takes an affidavit in court his signature must be authenticated. Ministers and Consuls abroad have power to take affidavits, and so have British Consuls and nearly all similar officers. No particular form of affidavit is prescribed. An affidavit of merit is one made by a defendant, which sets forth that he has stated his case to counsel and is by him advised that he has a good defence to the pending action on its merits. This is required to protect plaintiffs from delay by frivolous shows of defence, but does not always effect the purpose.

AFFIRMATION.—A substitute for swearing, or taking an oath. In most of the States a witness may, at his own option, either swear or affirm, and with the same legal effect. In the act of affirming the right hand is raised while the formula is spoken. Formerly, in England, no evidence could be given except upon oath; but the privilege of making a solemn affirmation, instead of swearing on the Bible, has been extended to Quakers, Moravians, and Separatists in all cases; and to persons alleging conscientious motives in civil proceedings. Before native Courts-Martial in India, evidence is given on solemn affirmation. For Quakers and Moravians the formula is: "I do solemnly, sincerely, and truly declare and affirm." In the case of Separatists this affirmation further bears to be emitted "in the presence of Almighty God." The penalties of perjury are imposed on those who shall be proved to have affirmed falsely. A later statute has extended the privilege of substituting an affirmation for an oath to all persons who refuse to be sworn from conscientious motives—*the Judge being satisfied that the motives are conscientious.*

AFFORCIAMENT.—An old term for a fortress or stronghold: now obsolete.

AFRANCESADOS.—A name given to the Spaniards who upheld the oath of allegiance to King Joseph Bonaparte; also called Josephins (in the Peninsular War).

AGA—AGHA.—The Turkish title of a superior Military Commander; also of the higher officers of the seraglio.

AGAVE.—A genus of plants belonging to the natural order *Amaryllideæ*, and having a tubular perianth with 6-partite limb, and a triangular, many-seeded inferior capsule. They are herbaceous plants, of remarkable and beautiful appearance. There are a number of species, all natives of the warmer parts of America. By unscientific persons they are often confounded with aloes. The agaves have either no proper stem, or a very short one, bearing at its summit a crowded head of large, fleshy leaves, which are spiny at the margin. From the midst of these shoots up the straight, upright scape, 24 to 36 feet high, and at the base often 1 foot in diameter, along which are small, appressed, lanceolate bracteæ, with a terminal panicle, often bearing as many as 4000 flowers. In South America these plants often flower in the eighth year, but in our hot-houses not until they have reached a very advanced age; whence arises the gardeners' fable of their flowering only once in a hundred years. After flowering, the plant always dies down to the ground, but the root continuing to live sends up new shoots. By maceration of the leaves, which are 5 to 7 feet long, are obtained coarse fibers, which are used in America, under the name of *maguey*, for the manufacture of thread, twine, ropes, hammocks, etc. This fiber is also known as pita flax. It is now produced to some extent in the south of Europe. It is not very strong or durable, and if exposed to moisture it soon decays.

AFRICA
SCALE OF MILES
0 200 400 600 800 1000
TURKEY
ASIA
PERSIA
AFGHANISTAN
BELOOCHISTAN
ARABIA
ARABIAN SEA
SYRIA
Damascus
Jerusalem
Medina
Mecca
Persian Gulf
Gulf of Aden
SOCOTRA
C. Guardafui
SPAIN
LISBON
MOROCCO
ALGERIA
EGYPT
NUBIA
ABYSSINIA
SOMALI
LIBYAN DESERT
SAHARA OR GREAT DESERT
SOUDAN
Timbuctoo
GUINEA
ASHANTEE
GULF OF GUINEA
Khartoum
Albert Nyanza
LOANGO
MOZAMBIQUE
ZANZIBAR I. & TN.
MADAGASCAR
TANANARIVO
Tamatave
MAURITIUS
Delagoa Bay
CAPE COLONY
Cape of Good Hope
C. Blanco
Ft. St. Louis
Cape Verde
CANARY ISLANDS
MADEIRA IS.
CAPE VERDE ISLANDS
TROPIC OF CANCER
EQUATOR
ATLANTIC OCEAN
INDIAN OCEAN
ASCENSION I.
ST. HELENA I.
SEYCHELLE IS.
AMIRANTE IS.
Meridian of Greenwich
Longitude West 20 of Greenwich
Longitude East 60 of Greenwich

The ancient Mexicans employed it for the preparation of a coarse kind of paper, and the Indians use it for oakum. The leaves, cut into slices, are used for feeding cattle. A species known as *Agave mexicana* is particularly described by Humboldt upon account of its utility. When the innermost leaves have been torn out, a juice continues to flow for a year or a year and a half, which, by inspissation, yields sugar; and which, when diluted with water and subjected to four or five days' fermentation, becomes an agreeable but intoxicating drink, called *pulque*, to which the Mexican Indians not unfrequently sacrifice both fortune and life.

AGEMA.—A kind of soldiery, in the ancient military art, chiefly in the Macedonian army. The word is Greek, and denotes vehemence, to express the strength and eagerness of this corps.

AGENCY.—A certain proportion of money which is ordered to be subtracted from the pay and allowances of the British Army for transacting the business of the several regiments comprising it.

AGENT.—In the British service, a person authorized by the government to manage the monetary affairs of regiments in the army, as a kind of military banker. In early times, persons were employed to effect the purchase and sale of commissions in the British army (the only army in which this strange system of purchase existed), without much reference to honesty or fitness; but to prevent pernicious trafficking, no one was after 1809 permitted to manage these transactions except the authorized Army Agent, under a heavy penalty. The Agents were also bound down by restrictions, in relation to any pecuniary advantage derivable by themselves from the sale and purchase. Their business, however, is now confined to the regular expenditure of government money. Every regiment has an Agent, selected by the Colonel, and empowered by him to be his representative in the monetary arrangements of the Corps. The Colonel is responsible to the Crown for the honesty of the Agent; but the Agent is in many ways regarded as a servant of the public. When money is wanted for the regular expenses of the regiment, the Agent applies to the War Office; whereupon the Secretary of State for War issues an order to the Paymaster of the forces to advance the requisite sum; the Paymaster does so, and takes a receipt from the Agent. There is an annual settlement of accounts between the Paymaster and the Agent, each one paying or receiving, according to the side on which excess or deficiency may appear. The Agent then distributes the pay and other charges of the regiment. The tendency of recent alterations has been greatly to reduce the public functions of the Agents, who now only receive £15,000 from the State, while in 1858 they had £40,000. The percentage allowed to Agents for their trouble in paying the full pay of officers was allowed for by the State, and was included among the annual army estimates; but the officer generally bore this charge in relation to half-pay and allowances. The Agent conducted all correspondence, and sent all the requisite notices concerning pay and payment; the Colonel of the regiment took no part in the matter. The details of the system varied considerably at different times, and in different portions of the British dominions. Sometimes the Agent received twopence in the pound on the amount of pay; sometimes three halfpence in the pound, with an addition varying from sixpence to one shilling per day for each company of infantry or troop of cavalry; sometimes (in Ireland and in the Colonies) a fixed annual salary. When the Colonels of regiments provided the men's clothing, under a system now abandoned, the Agents were very intimately mixed up with the transactions; but at present the duties of those Agents are limited to the following: applying monthly to the War Office for the money required for each regiment; receiving that money; applying part of it to the payment of officers; disbursing the regimental paymasters' bills for the cost of the expenditure; paying soldiers' remittances for the benefit of their families; settling the effects and credits of soldiers. Many experienced government officers have recommended the abandonment of the system, and the paying of all moneys by the War Office direct, as a measure of simplification and economy.

AGGER.—The middle part of a military road raised into a ridge, with a gentle slope on each side to make a drain for the water and keep the way dry. The term also denotes a work or fortification used both for the defence and attack of towns, camps, etc., termed among the moderns, lines. Agger is also used for a bank or wall erected against the sea or some great river to confine or keep it within bounds, and called by modern writers a sea-wall.

AGIADES.—A kind of pioneers in the Turkish armies, or rather field Engineers, employed in fortifying the camp, etc.

AGIEM-CLICH.—A very crooked saber, rounded near the point; an arm much in use in Persia and Turkey.

AGMEN.—The name given by the Romans to an army when on the march.

AGMINALIS.—The ancient name given to a horse which carried baggage, equipments, etc., on his back; now termed pack-horse.

AGUERRI.—A term frequently applied to an officer or soldier who is known to be experienced in war.

AIDE-DE-CAMP.—An officer who may be regarded as a kind of superior confidential attendant upon a General in active service. The Aide-de-Camp is the organ of the General. He carries all orders on the field of battle: these he is to deliver in the plainest terms, so as to be distinctly understood; and when so understood, the orders are to be as implicitly obeyed as if the General himself were present and speaking. As an example of the importance of this matter may be adduced the brilliant but disastrous light-cavalry charge at Balaklava in the autumn of 1854. Lord Raglan sent a message, partly verbal and partly written, to the Earl of Lucan concerning a particular piece of strategy at a certain time and place; the message was misconceived, and the Earl of Cardigan was directed to make a military movement perfectly hopeless in its character, resulting in a very serious cavalry loss; although the incident presented a fine display of heroism united with discipline. An Aide-de-Camp also acts as Secretary to the General, and assists him in his correspondence when he has not specifically a Military Secretary. He aids likewise in dispensing the courtesies of the General's house or tent. Generals are much accustomed to appoint their sons or other relations to this confidential post. Aide-de-camps vary in number according to the rank of the General Officer. In the British service, before an officer can be appointed as Aide-de-Camp, he must have been two years with his regiment, and must pass an examination. Aide-de-camps are not removed from the list of their regiments; and, most commonly, are Captains. Besides these Aide-de-Camps to Generals, the Queen has the power to appoint any number of Aide-de-Camps to herself, in her capacity of nominal Head of the Army. There are no particular duties attached to the office; but it is much sought after, both as an honor, and as conferring on the holder the rank of Colonel in the Army. There are six who receive daily pay as Aide-de-Camps, and who take it in turn to attend the Queen on State Occasions. In the year 1876 there were no fewer than 33 military Aide-de-Camps to the Queen, of whom 8 were Peers of the Realm; but of the 33, only 19 belonged to the army; the rest, except two of the marines, being militia officers, whose appointments are purely honorary. In addition to all the above, there are naval Aide-de-Camps to the Queen.

AID-MAJOR.—The French name for the Adjutant of a Regiment. It is still in use.

AIGREMORE.—A term used by the artificer in the laboratory to express the charcoal in a state fitted for the making of powder.

AIGUILLE.—An instrument used by Engineers to pierce a rock for the lodgment of powder, as in a mine, when blasting or blowing up is to be effected.

AIGUILLETTE.—A decoration, consisting of bullion cords and loops, which was formerly worn on the right shoulder of a General Officer, but is now chiefly confined to officers of the Life-Guards and Horse-Guards in England, and to officers of the Adjutant-General's Department, Aides-de-Camp, and Adjutants of regiments in the United States Army. The Aiguillette, instead of being permanently attached to the shoulder-knot, may be made separate so as to be attached to the coat underneath the knot by means of a strap or tongue passing through the lower fastening of the knot. Aides-de-Camp and the Military Secretary, who have *increased* rank, wear the Aiguillette with the uniform of the General Staff. Aides-de-Camp to Major- and Brigadier-Generals wear the Aiguillette with the uniform of their regiments and corps. See *Shoulder-knots*.

AILE.—A French term denoting a wing or flank of an army or fortification.

AILETTES.—Appendages to the armor worn by knights in the thirteenth century. They were sometimes made of leather, covered with a kind of cloth called *carda*, and fastened with silk laces. The form was sometimes circular, sometimes pentagonal, cruciform, or lozenge-shaped, but more usually square. Sometimes they were not larger than the palm of the hand; in other instances as large as a shield. In most instances, the Ailettes were worn behind or at the side of the shoulders. Whether the purpose of these appendages was as a defense to the shoulders in war, as an ensign or mark to indicate to the followers of the knight his place in the field, or as armorial bearings, is not now clearly known; but the first supposition is the most probable. Ailettes are figured on many effigies, monumental brasses, and stained windows in cathedrals and old churches.

AIM.—A word of command for bringing a musket, piece of ordnance, or any other missive weapon to its proper line of direction with the object intended to be struck. To aim a musket, raise the piece with both hands, and support the butt firmly against the right shoulder, the left elbow down, the right elbow as high as the shoulder, the body inclining slightly forward; incline the head upon the stock so that the right eye may quickly perceive the notch of the rear-sight, the front-sight, and the object aimed at; the left eye closed, the right thumb extended along the stock, the forefinger on the trigger. When recruits are formed in two ranks, the front-rank men lower the right elbow slightly, in order to facilitate the aim of the rear-rank men. Each rear rank man in aiming carries the right foot about eight inches to the right, toward the left heel of the man next on the right, inclining the upper part of the body forward, bending slightly the right knee.

The men, in squads of from twelve to twenty, are first instructed in the principles of aiming, which may be taught in-doors. To this end a target is made, having a black circle six inches in diameter for the center; exterior to it are four concentric rings, alternately white and black, each ring from two to four inches wide. The target is posted at various distances from a table, tripod, or other support, on which rests a sand-bag, the upper surface of which should be at the height of the shoulder. In the first lessons, a small white wafer will be pasted over the center of the target. The wafer and sand-bag being arranged, the instructor, who is always a commissioned officer, indents the sand-bag slightly, and, placing the musket on it, aims it accurately at the target. He then requires the men separately to examine the aim, causing them to close the left eye. He next deranges the piece and causes the men successively to direct it on the wafer, verifying each aim, and deranging it before the next man steps forward. The instructor next aims the piece above, below, to the right or left of the target, and requires the men to state the error and correct it. These lessons are repeated at different distances, the instructor exposing faults and requiring the men to correct them. To aim at objects beyond the *point-blank*, the instructor commands: (1) *At three hundred* (or *so many*) *yards*, (2) AIM. At the first command, the men seize the slide between the thumb and forefinger, open the leaf to the front, and move the slide until the upper line coincides with the distance marked on the leaf; the leaf is then placed at right angles to the axis of the piece. At the command *aim*, the men aim through the notch in the slide, and the front-sight. After firing, the leaf is turned back to its proper position.

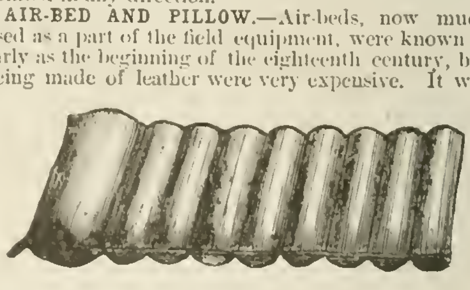
Having taught the principles of aiming, the instructor next impresses upon the minds of the men that accuracy of fire depends on pulling the trigger steadily. The piece being in the position of *ready*, the instructor directs each man to place the forefinger on the trigger, so that the second joint shall touch the right side. The trigger is pulled by a steadily-increasing pressure of the finger in the direction of the axis of the piece, the breath always being held from the commencement of the pressure till the hammer strikes. The men having become accustomed to the pressure necessary to discharge the piece, are next required to aim it carefully, either sitting or standing, and to pull the trigger, preserving the aim, keeping the right eye still directed on the object. If the trigger be pulled by a convulsive motion, the muzzle will be moved to the right. After learning to pull the trigger without deranging the aim, the men are taught to support the recoil by pressing the butt firmly against the shoulder with the right hand; the left hand supports the weight of the piece, and steadies it in aiming. The trigger is pulled as before. If the particular rifle carries higher or lower than the average, it must be remedied by aiming with a fine or a coarse sight. The men are next given blank cartridges to accustom them to the noise of the piece and further confirm them in the principles of aiming and firing. See *Manual of Arms*, Fig. 16.

AIM-FRONTLET.—A piece of wood hollowed out to fit the muzzle of a gun so as to make it level with the breech, formerly in use among gunners. Wooden front-sights on a similar principle are still used on board ship in case of emergency, as when an accident occurs to the proper metal sights.

AIMING-DRILL.—A military exercise of great importance as a preliminary step in teaching men to aim fire-arms.

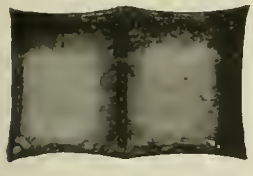
AIMING - STAND.—An instrument employed in teaching the theory of aiming with a musket. It usually consists of a tripod with a device mounted upon it which holds the gun and allows it to be pointed in any direction.

AIR-BED AND PILLOW.—Air-beds, now much used as a part of the field equipment, were known as early as the beginning of the eighteenth century, but being made of leather were very expensive. It was only after the invention of air-tight or Macintosh cloth that it became possible to use air in this way at a moderate cost. An air-bed as usually made consists of a sack in the form of a mattress, divided into a number of compartments, each air-tight; a projection at one end forms a bolster. Each compartment has a valve, through which the air is blown in by a bellows. The advantages of such beds in point of cleanliness, coolness, lightness, and elasticity are quite obvious. They are specially valuable in cases of sickness in the field, and in adding to the comforts of troops subjected to rapid move



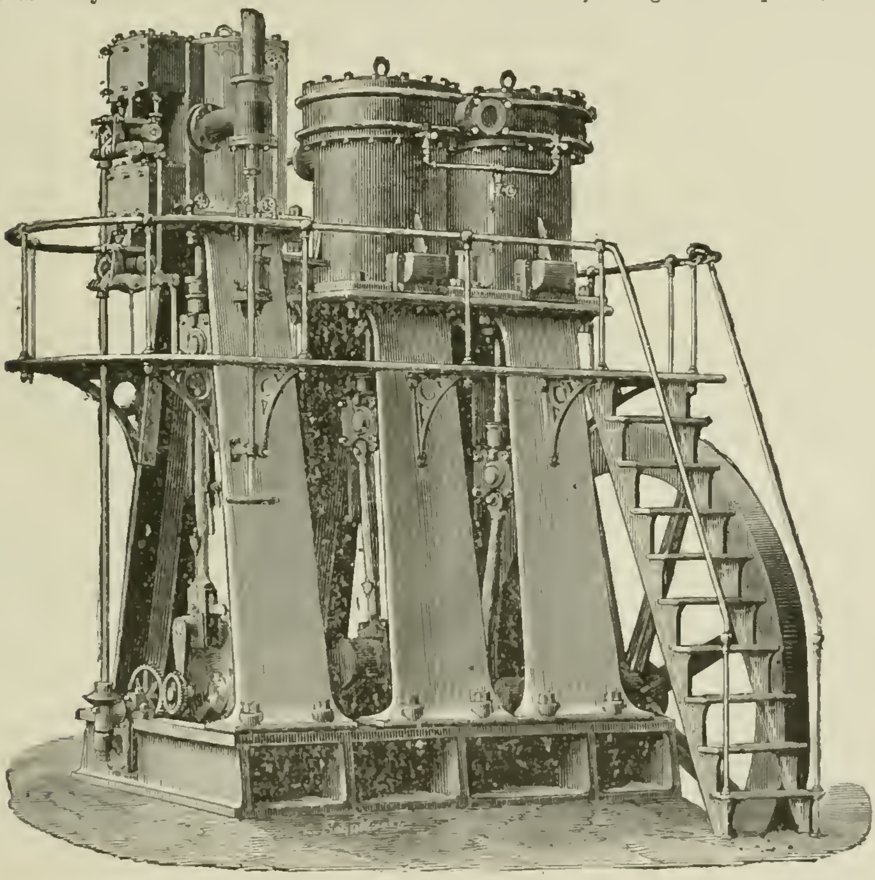
Air-Bed.

ments with limited means of transportation. The *air-pillow* is another contrivance of the same kind. Recently, vulcanized India-rubber, instead of cloth, has been used in the fabrication of such articles. The chief drawback to these contrivances is the liability to being spoiled by a rent or other injury. For use in localities where water is plentiful, these articles are constructed so as to be filled with water; but the air-filling is more satisfactory in all respects



Air-Pillow.

AIR-COMPRESSOR.—An obvious mode of employing air as a motive power is to compress it and then apply it in the manner of high-pressure steam. Although compressed air has been used for working small engines in confined situations, such as tunnels, it is not at all likely that it will ever come into extensive use, owing to the great waste of power attending it. This waste arises from two causes: first, the friction due to forcing the compressed air along a great length of pipe; and secondly, the loss from the dissipation of the great heat which results from its compression. If, say, 100 cubic feet of air is compressed into 1 cubic foot, it will become very hot, and although it is very easy to keep in the air, it is impossible to keep in the heat. In spite of every precaution, the heat will find its way through the vessel in which the air is confined, and through the pipes in which it is being transmitted, and this is equivalent to a portion of the air itself leaking out, because when the air is permitted to expand in working the engine, it will not attain the bulk it originally had of 100 cubic feet. The greater the original compression of the air, the higher its temperature will rise; and as this caloric, which cannot be kept from escaping, is practically a part of the bulk of the air, it follows that the loss of power from this cause will increase with the pressure or tension of the air. Even were it possible to prevent the escape of the heat by covering the vessels and pipes with some non-conducting substance, it would not be practicable to use the hot air in the same way as steam is used, because the lubricating material necessary to keep the piston and slide-valves from "tearing" would be decomposed by the high temperature. In steam-engines there is always a small quantity of water in the cylinders and slide-valves, arising from the condensation of a portion of the steam, and this suffices to lubricate the piston and valves. It is well known that when steam is *superheated* so highly as to prevent a slight condensation in the cylinder and slide-valves, they are very rapidly destroyed. Air rises in temperature when very much compressed, and we cannot use it until its temperature falls; and as this involves a great waste of power, it follows that where economy is of great consequence, air cannot be used as a mode of transmitting mechanical power. Indeed, no fluid can be economically used for transmitting power for any great distance. We have just seen that compressed air is very unsuitable; steam is even more wasteful, because it condenses into water in long pipes. Water itself loses much of its force from friction in passing through long pipes, unless they are of very large size; and in applying it to hydraulic cranes, where the weight to be raised varies, great waste of power arises from the fact that the cylinder in which the ram works has to be filled every time the crane is worked with water at the full pressure of 600 or 700 pounds to the square inch, even when a pressure one tenth of that amount would suffice to raise the weight. In short, the power actually used in working an hydraulic crane is always the maximum, even when the weight to be raised is a minimum. It



Burleigh Air-Compressor.

uses as much power to lift a hundred-weight as it does to lift a ton. The extreme handiness and other practical advantages possessed by the hydraulic cranes leave a large balance in their favor, notwithstanding their waste of power. In boring the Mont Cenis tunnel, air was compressed at the mouth of the tunnel by the abundant water-power easily obtainable there, and forced along to the working face through small iron pipes, for working the boring-machines. The tunnel through the Hoosac Mountain in Massachusetts has also been bored by compressed air working the rock-drills. The drawing represents the Burleigh Air-Compressor used in that work. It consists of a steam-engine connecting by means of a crank-shaft with two single-acting air-pumps. Want of space will not permit a description of this beautiful machine in detail; nor is it necessary. It is a compactly built, close-working machine, whose lines of motion are all the same, and whose action is such, and the play of the various parts so nicely balanced, that the strain upon them is equalized, counteracted, and brought within itself. By a nice adjustment of the cranks in their relation to each other, the greatest power of the engine is applied at the exact point of greatest resistance, so as to produce the best results at the least cost. The air, when compressed, is taken into a tank, or air-chamber, and thence carried to any desired point in pipes, in the same manner that steam is carried. Connection between the permanent pipes and drills upon the carriages is made by flexible rubber pipe, which is uncoupled when the carriage is run back for a blast. In reference to this machine, it may be added that drilling by compressed air is only one of the uses to which it may be applied, and to which it will eventually be made available: such as the ventilation of buildings; transmitting messages, packages, or passenger-cars in pneumatic tubes; driving street-cars; or supplying a very convenient and perfectly safe motor for running machinery. The feasibility of compressing air at any convenient point, and conveying it in iron pipes exactly as gas or water is carried along the streets of our cities, to be tapped and used wherever required, has already been demonstrated, and it cannot be doubted that ere long the plan will come into general use. It thus constitutes an efficient, handy, and safe power; makes no dirt or obnoxious gases; but, when exhausted into a room, after doing its work in the machines, furnishes the most ample and desirable ventilation. In this manner, power may be carried a great distance at comparatively small expense. At the Hoosac Tunnel the Burleigh Rock-Drill Company have carried it over three miles with no material loss of power.

AIR-CYLINDER.—A pneumatic buffer used in America to absorb the recoil of large guns. For 10-inch guns, one cylinder is used; for 15-inch guns, two. They are placed between the chassis-rails, to which they are firmly secured by diagonal braces. A piston traversing the cylinder is attached to the rear transom of the top carriage. When the gun recoils the piston-head is drawn backwards in the cylinder, and the recoil is absorbed by the compression of the air behind it. Small holes in the piston-head allow the air to slowly escape while the gun is brought to rest. The Hydraulic Buffer, largely used abroad, operates in the same way, water being used instead of air. See *Pneumatic Buffer*.

AIR-DRILL.—A drill driven by the elastic pressure of condensed air, and employed in mining and tunneling. The construction usually resembles the reciprocating steam-engine, compressed air being substituted for the steam; the drill-stock is attached to the piston-rod. See *Pneumatic Drill.*

AIR-ENGINE.—It is a well-known law, applicable to all thermo-dynamic engines, that (presupposing the merely mechanical part of the machine to be perfect) the heat converted into work bears the same proportion to the total heat given to the fluid that the range of temperature bears to the highest *absolute* temperature of the fluid. Thus, supposing an engine to receive steam at the temperature of 275° F. and discharge it at that of 120° F., the fraction of heat which it can convert into work will be $\frac{275-120}{275+461}$, or about 21 per cent of the total heat of the fluid. This proportion would be, of course, greatly reduced in practice, owing to imperfections in the machinery; but these being equally likely to occur in all prime movers, we need not consider them here. The *lowest* limit of temperature available being practically constant, fixed either by the temperature of the atmosphere or that obtainable in a condenser, it follows that greater economy can only be looked for

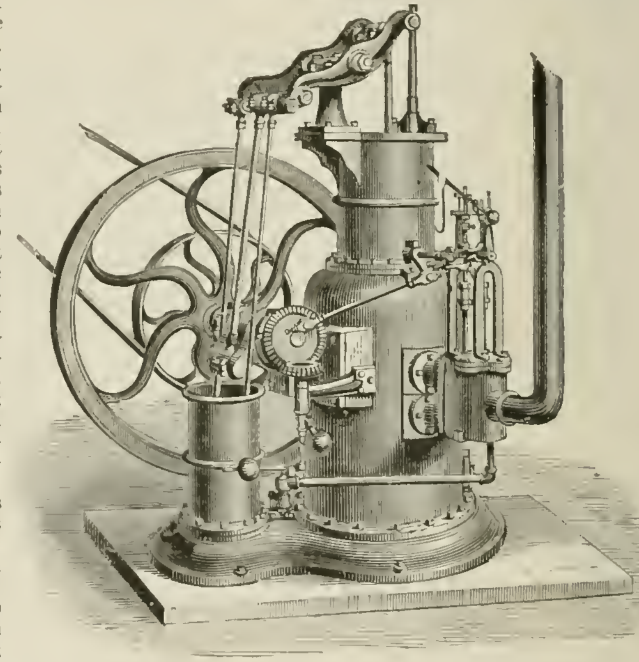


Fig. 1.

in the direction of increase of initial temperature. In ordinary steam-engines, in which the pressure and temperature increase simultaneously, the latter is limited by the former, which in its turn is kept, by considerations of safety, comparatively low. When, however, *superheated* steam (steam to which additional heat has been imparted without the corresponding addition of pressure) or heated air is used, the temperature is limited only by the power of the metals composing the machine to resist the destructive action of heat, or the chemical action of the fluid at that temperature. Heated air possesses the advantage over superheated steam as a motive power, that with it an explosion, in the usual sense of the word, is rendered almost impossible, and that, if one were to occur, it would be comparatively harmless. It also, of course, enables the boiler to be dispensed with.

Air-engines, in their principal working parts, are very similar to ordinary steam-engines. The heated air is introduced into a cylinder, as in Fig. 1, in which works a tightly-fitting piston, which is thus compelled to move up and down, and transfers its motion to a revolving shaft by means of a piston and connecting-rod in the usual manner. The motion of the piston results in all cases from the expansion of the heated air; the air is heated by means of a furnace, is introduced below the piston, raises it, and then is allowed to escape into the atmosphere. Air-engines are almost invariably single-acting; they are sometimes worked simply by heated air, and sometimes with the air which, having passed through the furnace, is mixed with all the gaseous products of combustion. The latter method has the immense advantage that it utilizes the heat which would otherwise be rejected into the chimney. The total efficiency of the machine is thus increased, although the efficiency of the engine proper, between the given pair of temperatures, remains the same.

The more heat carried away by the discharged air (the higher its temperature, in other words) the smaller evidently is, *cæteris paribus*, the range of temperature of the machine, and the less, therefore (as already explained), will be its efficiency. The distinctive principle of the Messrs. Stirling's air-engine consists in utilizing a great part of this wasted heat, and thus economizing fuel. This is effected by means of a "regenerator," or, more properly, "economizer," consisting of a chamber filled with metallic sieves of wire-gauze, through which the hot air is

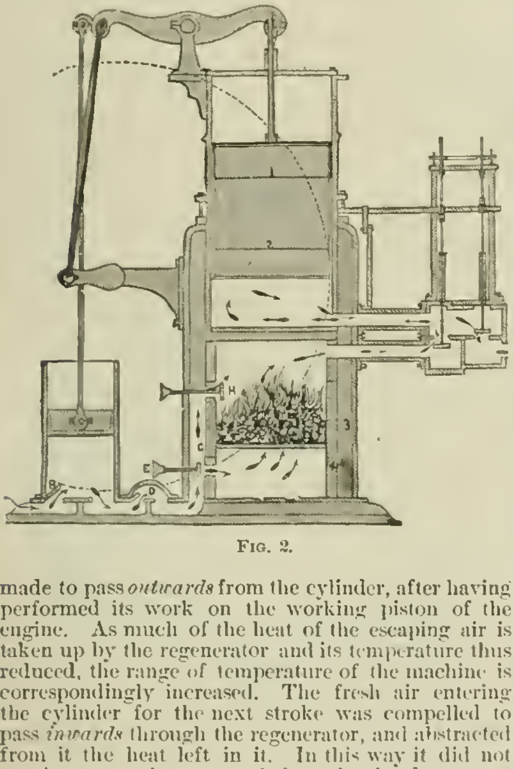


Fig. 2.

made to pass *outwards* from the cylinder, after having performed its work on the working piston of the engine. As much of the heat of the escaping air is taken up by the regenerator and its temperature thus reduced, the range of temperature of the machine is correspondingly increased. The fresh air entering the cylinder for the next stroke was compelled to pass *inwards* through the regenerator, and abstracted from it the heat left in it. In this way it did not require to receive so much heat in the furnace as would otherwise have been the case, and thus economized fuel. This method of preventing waste of heat was first discovered by the Rev. Dr. Stirling, who obtained a patent for it in 1816. In working with air at the ordinary pressure of the atmosphere, however, the engine was found to require to be of large dimensions as compared to a steam-engine of the same power; and in order to obviate this objection, compressed air was used. Several other difficulties were successfully surmounted by the Messrs. Stirling, and eventually two improved engines were constructed, one of which was tested to fully 40 horse-power. This latter engine did all the work of the Dundee Foundry Company regularly for upwards of three years, during which period they employed no other motor. At the end of this period it was laid aside, principally owing to the repeated failure of one of the heating vessels.

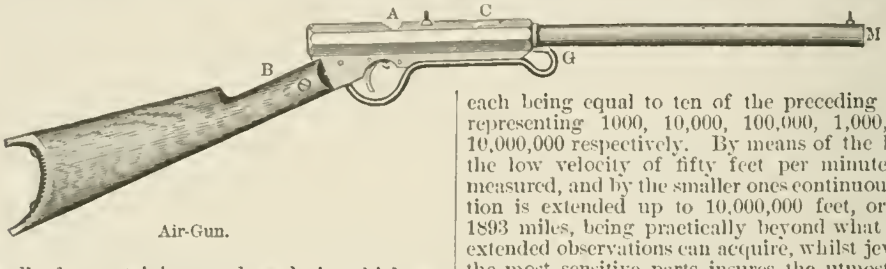
Captain Ericsson, in his attempt to introduce his caloric engine in the ship which bore his name, experienced precisely the same difficulties and disappointments, and tried nearly the same remedies, as the Messrs. Stirling. There seems little doubt, however, that he actually believed his "regenerator" was to make the *same heat* do work over and over again—to be a kind of perpetual motion—and under these circumstances it is not to be wondered at that his machines (notwithstanding some not very creditable maneuvering on the part of their upholders) entirely failed, and that in two years they were replaced by steam-engines. Air-engines have recently been constructed, in which the solar rays, concentrated by means of an arrangement of mirrors, are utilized as the source of heat. These have been called Solar Engines.

The improved Roper Engine, shown in section in Fig. 2, is regarded as a most satisfactory power for the light work of the Arsenal and Foundry. It is not an experiment, but a reliable power within the range of the sizes manufactured, built in a strong and substantial manner by skilled mechanics, and has proved by years of constant use that it really possesses the advantages claimed for it. Coal and air are the agencies employed in a way which insures the most perfect economy of the former and greatest expansion of the latter. The air at the temperature of the surrounding atmosphere is drawn into the air-pump and then forced directly into the fire, which burns in an air-tight furnace; combustion and expansion ensue, and as a result of the expansion of the air and gases produced by combustion a pressure is obtained in the fire-box, which is admitted to the cylinder and exhausted through valves, as a steam-pressure would be operated. The furnace is lined with heavy fire-brick, and as the air is brought in contact with the *fire*, and not hot iron plates, there are no heating surfaces to be destroyed by use.

During the past few years a number of small steam-engines have been placed in some of the Arsenals, being from their low price attractive to the managers. But however small such an engine may be, or however skillfully made, the fact remains that a steam-boiler requires the constant attention of an experienced man, and, as shown by frequent explosions, is dangerous under the most favorable circumstances. Any inexperienced person can, with a few instructions, take care of an air-engine as well as the best engineer, and in such a short time that his other duties would scarcely be interfered with. The wages of an engineer is a large item where a small amount of power is used, and is in many cases more than the power is actually worth. When this sum is added to the amounts saved in fuel and insurance, the result will show that an air-engine will pay for itself in a very short time, while the satisfaction of having a power which is in any case absolutely safe is a point not to be overlooked. No water being used either to make steam or condense air, the trouble and expense of keeping pipes in order is avoided, and there is no moisture about the engine to cause rust when not in use. The exhaust air can be conducted away in pipes, and used to warm rooms, heat japanning-ovens, or other industrial uses.

AIR-FURNACE.—A foundry term used to signify a furnace having a natural draft, no blast.

AIR-GUN.—An instrument resembling a musket, used to discharge bullets or darts by the force of compressed air instead of gunpowder. Various forms of construction have been adopted. The most usual plan is to insert a condensing syringe in the stock of the gun. The piston of this syringe is worked by an apparatus which passes through to the exterior of the gun; and this working causes a small body of air to be condensed into a chamber. The chamber has a valve opening into the barrel, just behind the place where the bullet is lodged. The gun is loaded from the muzzle, as ordinary muskets or fowling-pieces; and there is at that time just behind it a small body of highly compressed air, ready to rush out at any opening. This opportunity is afforded by a movement of the trigger, which opens the valve; the air rushes forth with such impetuosity as to propel the bullet. By a certain management of the trigger, two or three bullets, successively and separately introduced, can be fired off—if firing it can be called—by one mass of condensed air. Another form of Air-gun contains several bullets in a receptacle or channel under the barrel; by the movement of a cock or level one of these bullets can readily be shifted into the barrel; and thus several successive discharges can be made after one loading—on a principle somewhat analogous to that of the revolving pistol. Some varieties of Air-gun have the condensing syringe detached, by which means a more powerful condensation of air may be produced; this done, the air-chamber is replaced in its proper position behind the bullet in the barrel. Those Air-guns which present the external appearance of stout walking-sticks, and are thence called Air-canes, have a chamber within the handle for containing condensed air, which can be unscrewed and subjected to the action of the condensing syringe. One inventor has devised a form of Air-gun with two barrels—one of small bore for the reception of the bullets, and another of larger bore for the reservoir of condensed air; the condensing syringe being within the stock of the gun. An attempt has more recently been made to combine the action of elastic springs with that of compressed air in an Air-gun; springs of gutta-percha, or of vulcanized India-rubber, are employed in substitution of or in co-operation with a condensing syringe. No form of Air-gun hitherto made has had power enough to propel a bullet to any considerable distance, and therefore the instrument is scarcely available in war; there are, however, circumstances in which such an arm may be useful—seeing that there is no expense for gunpowder, no noise, no smoke, no unpleasant odor. The Air-gun was known in France more than two centuries ago; but the ancients were acquainted with some kind of apparatus, by which air was made to act upon the shorter arm of a lever, while the larger arm impelled a bullet. The drawing represents an Air-gun, operated in the following manner: Place the hollow of the right hand against the breech (B), the muzzle (M) upon the floor or against some firm object, and push the barrel into the cylinder (C) as far as possible, or until the trigger catches the piston and holds it. Insert the dart or bullet well into the barrel at the opening (A), and draw out the barrel forward as far as it will go. To make the trigger pull off easier, tighten the set-screw in it. To pull off harder, loosen it a little. Should the gun lose its force and require cleaning, take it apart, wipe clean the piston and inside of cylinder, and return the parts to their places as before. If the barrel works hard, or does not slip freely, apply a drop of *thin* oil around it at the opening (A) and guard slot (G). See *Quackenbush Air-gun.*

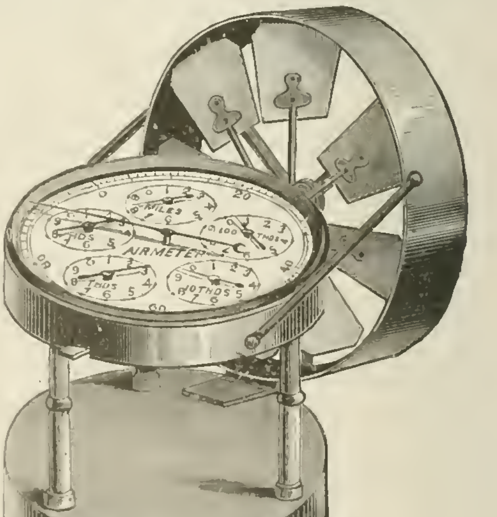


Air-Gun.

AIR-HOLE.—1. A hole or cavity in a gun-casting produced by bubbles of air in the liquid metal; also, a vent-hole in a mould for casting. 2. A draught-hole in a furnace. It is sometimes guarded by a register, but more frequently stopped by a luting or plug of clay.

AIRING-STAGE.—A platform on which powder, etc., is dried by exposure to sun and air.

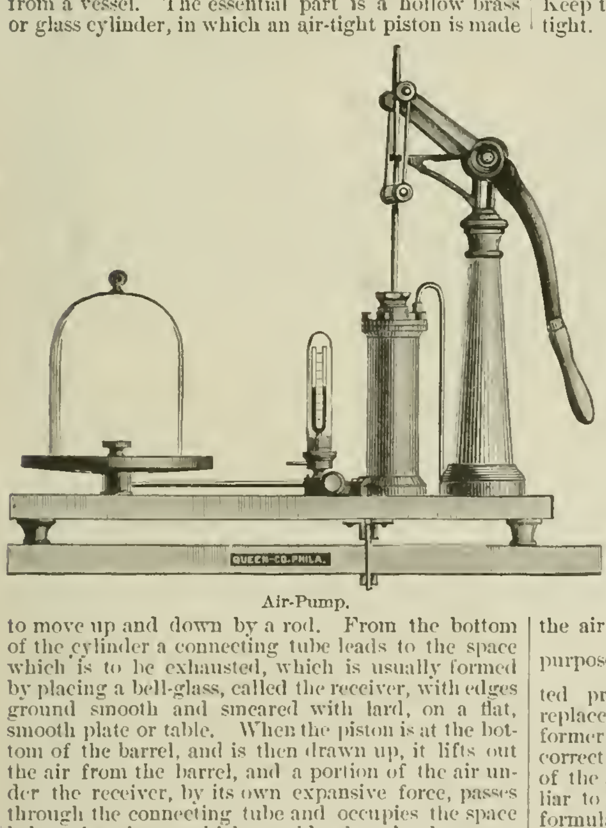
AIR-METER.—An apparatus for measuring the quantity of air passing along a pipe, or passing into or from a chamber. There are various forms: the fan, rotating spiral vane, expanding bag, cylinder and piston, revolving partially submerged meter-wheel, etc.,—all more or less used in Arsenals, Hospitals, and Laboratories. The drawing represents the Casella Air-meter, specially adapted for measuring the velocity of currents of air passing through mines, and the ventilating spaces of hospitals and other public buildings. The graduations for each instrument are obtained by actual experiment by means of machinery made for the purpose, so that the indications of all are as comparable with each other as the weight or measure of ordinary substances. The indications are shown by means of the large dial and hand, and five smaller ones, as shown in the drawing. The whole circumference of the large dial is divided into 100 parts, and represents the number of feet up to 100 traversed by the current of air. The five smaller dials are each divided into ten parts only, one revolution of each being equal to ten of the preceding dial, and representing 1000, 10,000, 100,000, 1,000,000, and 10,000,000 respectively. By means of the large dial the low velocity of fifty feet per minute may be measured, and by the smaller ones continuous registration is extended up to 10,000,000 feet, or equal to 1893 miles, being practically beyond what the most extended observations can acquire, whilst jewelling in the most sensitive parts insures the utmost delicacy of action. By moving a small catch backwards or forwards the work is put in or out of gear without affecting the action of the fans; this prevents the in-



Air-Meter.

jurious effect of stopping them suddenly, and enables the observer to begin or end his observations to a second. A small handle with universal joint accompanies the instrument, and may be screwed in at the base; by putting a stick through this it may be raised or lowered to any required height and used in any position. To use the Air-meter, write down the position of all the hands. For this purpose place the instrument before you, with the 0 on the outer circle facing you. The first circle on the left hand indicates hundreds of feet, the next thousands, the third tens of thousands, the fourth hundreds of thousands, and the last circle to the right of the 0 marks millions. Begin to write down the position of the hands with the million circle, and then go round from right to left, always writing down the lower of the two numbers if the hand is between two. Let us say that the hand on the million dial is at 0, the one-hundred-thousand hand between 2 and 3, the ten-thousand between 7 and 8, the thousand between 1 and 2, the hundred at 5, and the large hand which marks units and tens at 73. The million hand would be omitted as it has not reached 1, and the remaining numbers would run 271,573. The instrument is then put in the current to be measured, and when removed after a given time is read in the same way; the first being deducted from the second reading gives the velocity (uncorrected) in feet during the time. A simple table accompanies each Air-meter, by means of which (in strict observations) allowance may be made for the difference caused by inertia at high and low velocities. See *Anemometer*.

AIR-PUMP.—An instrument for removing the air from a vessel. The essential part is a hollow brass or glass cylinder, in which an air-tight piston is made



Air-Pump.

to move up and down by a rod. From the bottom of the cylinder a connecting tube leads to the space which is to be exhausted, which is usually formed by placing a bell-glass, called the receiver, with edges ground smooth and smeared with lard, on a flat, smooth plate or table. When the piston is at the bottom of the barrel, and is then drawn up, it lifts out the air from the barrel, and a portion of the air under the receiver, by its own expansive force, passes through the connecting tube and occupies the space below the piston, which would otherwise be a vacuum. The air in the receiver and barrel is thus *rarefied*. The piston is now forced down, and the effect of this is to close a valve placed at the mouth of the connecting tube and opening inwards into the barrel. The air in the barrel is thus cut off from returning into the receiver, and, as it becomes condensed, forces up a valve in the piston, which opens outwards, and thus escapes into the atmosphere. When the piston reaches the bottom and begins to ascend again, this valve closes; and the same process is repeated as at the first ascent. Each stroke thus diminishes the quantity of air in the receiver; but from the nature of the process it is evident that the exhaustion can never be complete. Even theoretically there must always be a portion left, though that portion may be rendered less than any assignable quantity; and practically the process is limited by the elastic force of the remaining air being no longer sufficient to open the valves. The degree of rarefaction is indicated by a *gauge* on the principle of the barometer. By means of the partial vacuum formed by the air-pump a great many interesting experiments can be performed, illustrating the effects of atmospheric pressure and other mechanical properties of gases.—The air-pump was invented by Otto Guericke, in 1654; and though many improvements and varieties of structure have been since devised, the principle of all is the same. Two barrels are generally used, so as to double the effect of one stroke. In some air-pumps, stop-cocks turned by the hand take the place of valves, and in others the entrance of the connecting tube into the cylinder is so contrived that the valve through the piston is not required. The air-pump is used with much frequency in the Laboratory and Arsenal. That used in connection with the densimeter is of the ordinary construction. The precautions to be observed in using the pump are: 1. Always keep the piston-rod and piston well oiled. 2. Keep the cocks, and the connections of the tube, air-tight. 3. Screw down the vacuum-gauge case securely before commencing to exhaust. The vacuum-gauge will show whether air is admitted, and the leak may be located by the hissing sound made by the air rushing in.

AIR-RESISTANCE.—This subject, with reference to projectiles, is of the highest importance in the science of Ballistics. The resistance increases in a high ratio with the velocity. Without this resistance a musket-ball would, at an angle of 25°, be thrown seventeen times further than with it. Hutton's experiments led him to believe that the resistance of the air increased a little more rapidly than the square of the velocity. The French experiments have led to an expression involving the square and the cube of the velocity. It is of the following form for spherical projectiles:

$$\rho = 0.0005213\,\pi\,Rv^2 \left(1 + \frac{v}{1426.4}\right)\frac{\delta}{534.5},$$

in which ρ represents the resistance of the air in pounds weight; π, the ratio of the circumference to the diameter; R, the diameter of the projectiles in feet; v, the velocity in feet per second; and δ, the density of the air at the time of observation. For ordinary purposes $\frac{\delta}{534.5}$ may be taken as unity. For elongated projectiles the coefficient 0.0005213 = A is replaced by 0.0003475; but in some instances the former coefficient has been found to be the more correct even for elongated projectiles. The resistance of the air gives rise to a ballistic coefficient C, peculiar to each projectile. This is calculated from the formulæ

$$C = \frac{1}{2g}\,\frac{P}{A\pi R^2} = \frac{2}{3}\,\frac{R\,D}{gA},$$

in which g, A, π, R are the same as before; P, weight of projectile in pounds; D, the density of the projectile; and A, its appropriate value, according as the projectile is spherical or elongated. The coefficient C is one of the data required in finding the multipliers B (a point), D, etc., used in the formulæ for the trajectory in the air. Colonel Majefsky, of the Russian artillery, has proposed a formula involving the square and the fourth power of the velocity, which is said to give results even closer to practice than the French formulæ above detailed. The following table, calculated by the formulæ, will give an idea of the amount of the resistance of the air:

Velocity of Projectiles.	Resistance in lbs. Avoirdupois			
	24 pdr. Shot	12 pdr. Shot	Musket Bullet.	10-inch C.Shell.
1600 feet	479	302	7	...
1400 "	343	216	5	...
1200 "	231	147	8	...
1000 "	150	95	2	462
800 "	88	56	1	271
600 "	45	28	0 7	139
400 "	18	11	0.3	56

On examining the above, it appears that the resistance decreases very rapidly with the velocity. In effect, at a velocity of 800 feet the resistance is less than one fifth of that corresponding to the double velocity of 1600 feet. Comparatively to the 24-pdr. round shot, the resistance to the 12-pdr., one half its weight, is only about two thirds of the former; that to the musket-bullet, weighing $\frac{1}{314}$ of the same round shot, is but the 68th part. The 10-inch common shell, weighing nearly four times as much, meets with a resistance which is only three times that of the 24-pdr., despite the inferiority of its density. At a velocity of 1600 feet per second, the resistance opposed to the 24-pdr. shot is 479 lbs., or twenty times its own weight; at a much smaller velocity of 600 feet per second, the resistance to projectiles is still in proportion to their weight; thus, nearly double for the 24-pdr., more than double for the 12-pdr., nearly ten times for the musket-bullet, and nearly half as great again for the 10-inch shell.

AIR-SHAFT.—A shaft in a mine, usually vertical or nearly so, by which the mine is ventilated.

AITCH PIECE.—In mining, the part of a plunger-lift in which the clacks are fixed.

AKETON.—A quilted leathern jacket worn under the armor of knights in the thirteenth and fourteenth centuries; also written *Hacqueton*. See *Gambeson*.

AKINDSCHI.—A sort of Turkish cavalry, employed during the war between the Turks and the German Emperors.

ALA.—A word signifying the wing of an army; also sometimes used to designate a brigade of cavalry occupying a position, in battle, on either wing.

ALACAYS.—A name given by the ancients to a kind of soldiery, and afterwards to servants following an army.

ALAGE.—A mounted guard of the Byzantine Emperors, doing duty in the Palace of Constantinople, and defending, in case of danger, the person of the Emperor.

ALAIBEG.—A Turkish commander of regiments of levied troops.

ALANDA.—The name of a legion formed by Julius Cæsar from the best warriors of the Gauls.

ALARES.—The name given by the Romans to troops which were placed on the wings of an army. These troops were generally furnished by the Allies.

ALARM.—In military matters, the word alarm has a more defined meaning than mere terror or fright. An alarm, among soldiers in an army, is not so much a danger as a warning against danger. An alarm, signified by the firing of a gun or the beating of a drum, denotes to an army or camp that the enemy is suspected of intending a sudden surprise, or that the surprise has actually been made. There is an *alarm-post* in camp or garrison arrangements, to which the troops are directed to hasten on any sudden alarm being given.

ALARM GUN.—A gun prepared to give an alarm. Formerly, in the British service, three guns were placed in front of a camp, one hundred paces from the artillery-posts, ready to be fired, as an alarm to the troops, in case of a sudden attack by the enemy.

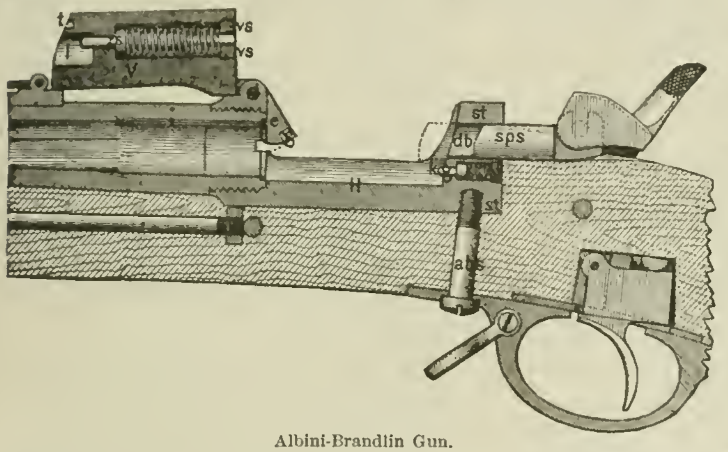
ALARM POST.—A place designated on the arrival of a force into a new quarter, camp, or bivouac, where the men are to repair in case of any sudden alarm by day or night. The parade is generally looked upon as the alarm post; officers and men should proceed there ready armed, on the alarm being sounded, should no other place be appointed. When an army is in the field, there are two alarm-signals: 1. For general concentration, on which everybody acts according to instructions; 2. Partial, when regiments reassemble at their own rendezvous. The second alarm-signal should be frequently practised, for it is very important to know how long it takes to get the men together at any hour. It is ordered in the Queen's Regulations that although a regiment or a division may remain for only a single night in a quarter, yet an alarm-post, or place of assembly, is invariably to be established in each regiment, and the troops are to be made acquainted with its position, and officers commanding regiments with that of the brigade to which they belong.

ALAY.—A Turkish ceremony on the assembling of the forces at the breaking out of a war; essentially a public display of the sacred standard of Mohammed, which may be looked upon only by Moslems and touched only by Emirs. Once when the standard had been shown the rule was forgotten, but when remembered all the Christians who had innocently looked at the banner were slaughtered.

ALBESIA.—In antiquity, a kind of shield; otherwise more frequently called *decumana*.

ALBIGENSES.—A name applied loosely to the "heretics," belonging to various sects, that abounded in the south of France about the beginning of the thirteenth century. The chief sect was the Cathari; but they all agreed in renouncing the authority of the Popes and the discipline of the Roman Church. The name arose from the circumstance that the district of Albigeois in Languedoc—now in the Department of Tarn, of which Albi is the capital—was the first point against which the crusade of Pope Innocent III., 1209, was directed. The immediate pretence of the crusade was the murder of the papal legate and inquisitor, Peter of Castelnau, who had been commissioned to extirpate heresy in the dominions of Count Raymond VI. of Toulouse; but its real object was to deprive the Count of his lands, as he had become an object of hatred from his toleration of the heretics. It was in vain that he had submitted to the most humiliating penance and flagellation from the hands of the legate Milo, and had purchased the papal absolution by great sacrifices. The legates Arnold (Abbot of Citeaux) and Milo, who directed the expedition, took by storm Beziers, the capital of Raymond's nephew, Roger, and massacred 20,000—some say 40,000—of the inhabitants, Catholics as well as heretics. "Kill them all," said Arnold; "God will know his own!" Simon, Count of Montfort, who conducted the war under the legates, proceeded in the same relentless way with other places in the territories of Raymond and his Allies. Of these, Roger of Beziers died in prison, and Peter I. of Aragon fell in battle. The conquered lands were given as a reward to Simon of Montfort, who never came into quiet possession of the gift. At the siege of Toulouse, 1218, he was killed by a stone, and Counts Raymond VI. and VII. disputed the possession of their territories with his son. But the papal indulgences drew fresh crusaders from every province of France to continue the war. Raymond VII. continued to struggle bravely against the legates and Louis VIII. of France, to whom Montfort had ceded his pretensions, and who fell in the war in 1226. After hundreds of thousands had perished on both sides, a peace was concluded, in 1229, at which Raymond purchased relief from the ban of the Church by immense sums of money, gave up Narbonne and several lordships to Louis IX., and had to make his son-in-law, the brother of Louis, heir of his other possessions. These provinces, hitherto independent, were thus, for the first time, joined to the kingdom of France; and the Pope sanctioned the acquisition in order to bind Louis more firmly to the papal chair and induce him more readily to admit the inquisition. The heretics were handed over to the proselytizing zeal of the Order of Dominicans and the bloody tribunals of the inquisition; and both used their utmost power to bring the recusant Albigenses to the stake, and also, by inflicting severe punishment on the penitent converts, to inspire dread of incurring the Church's displeasure. From the middle of the thirteenth century, the name of the Albigenses gradually disappears. The remnants of them took refuge in the East, and settled in Bosnia.

ALBINI-BRANDLIN GUN.—The system of alteration which has been adopted in the Belgian service is known as the Albini-Brandlin. It is peculiarly fitted for transforming small-arms to breech-loaders, and, with the exception of the locking and firing arrangements, closely resembles what is known as the Springfield system of this country. The parts are shown in the drawing. The breech-block, V, is hinged at its forward end, and in opening swings upward and forward. The recoil is taken on the rear portion of the receiver by the vertical part, *s t*. At the centre of this part is the hole, *d b*, through which passes the locking-bolt, *s p s*. This locking-bolt is jointed to the hammer, and pushed forward by it when the lock is sprung so as to penetrate the recess, *l*, of the breech-block and hold it securely in place at the moment of firing. At the same time that the



Albini-Brandlin Gun.

locking-bolt enters the recess it strikes against the head of the firing-pin, *z s*, the point of which impinges against and explodes the primer of the cartridge. As the firing-bolt does not lock the breech-block when the hammer is at half or full cock, the spring catch-pin, *k g*, is provided, which penetrates the recess, *t*, and prevents the block from getting loose under ordinary disturbing causes. The firing-pin, *z s*, is provided with a spiral spring to push it back and keep its point below the face of the block at all times except when pressed by the locking-bolt; this spring is kept in place by the screw-nut, *v s, v s*. The forward guard-screw, *a b s*, penetrates into the rear portion of the receiver, thereby securing the barrel to the stock. The extractor is formed of two lever-disks, *e*, pivoted to the hinge-pin and outside of the ears of the hinge. Each disk is provided with a hook-point, *g*, which passes through a cut in the receiver and barrel and takes hold on opposite sides of the head of the cartridge beneath the rim. When the breech-block is thrown forward to open the breech, its upper and forward edge strikes against the short arm of the extractor-disks and pushes them downward; at the same time the opposite or long arm is thrown to the rear, carrying with it the cartridge-shell. To throw the shell clear of the receiver the forward motion of the breech-block should be very quick toward its close. This extractor is very efficient, inasmuch as it gets a double hold on the rim of the cartridge-shell. See *Small-arms*.

ALCAIDE—ALCAYDE.—A Moorish title, applied by Spanish and Portuguese writers to a military officer having charge of a fortress, prison, or town. It is to be distinguished from *Alcalde*, which indicates a civil officer.

ALCANTARA.—The Order of Alcantara, a religious order of Spanish knighthood, was founded (1156) as a military fraternity for the defense of Estremadura against the Moors. In 1197 Pope Celestine III. raised it to the rank of a religious order of knighthood; bestowed great privileges on it, and charged it with the defense of the Christian faith, and the maintenance of eternal war with the infidel. Alphonso IX., having taken the town of Alcantara, ceded it in 1218 to the Order of Calatrava; but the knights of this order, unable to hold it along with their other great possessions, yielded it to the knights of St. Julian, who transferred it to their seat, and henceforth were known by its name. At length the grand-mastership of the order was, by Pope Alexander VI., united to the Spanish crown in 1495. The order is still richly endowed. The knights, who follow the rule of St. Benedict, take now only the vows of obedience and poverty, having, since 1540, been absolved from that of celibacy. A special vow binds them to defend the immaculate conception of the Virgin. At their nomination they must prove four generations of nobility. For a time the knights of Alcantara acknowledged the superiority of the knights of Calatrava, but they were latterly absolved from it. Both the costume, however, and the cross are still the same, with the exception of the color, which is green. The crest of the order is a pear-tree.

Order of Alcantara.

ALCOHOL.—A term of Arabic origin, implying the pure spirit obtained by distillation from all liquids which have suffered the vinous fermentation. Alcohol is transparent, colorless, and inflammable. It unites easily with resins, camphor, antimony, and volatile oils. It is known as "spirits of wine." Its specific gravity on becoming absolute alcohol is from .796 to .800, and it boils at 176°. It is used in the preparation of laboratory stores, such as fulminate of mercury, quick-match, shell-lac to form varnish for percussion-caps, etc.

ALDER.—A genus of plants of the natural order *Betulaceæ*. The genus consists entirely of trees and shrubs, natives of cold and temperate climates; the flowers in terminal, imbricated catkins, which appear before the leaves; the male and female flowers in separate catkins on the same plant; the male or barren catkins loose, cylindrical, pendulous, having the scales 3-lobed, and each with three flowers whose perianth is single and 4-partite; the fertile catkins oval, compact, having the scales sub-trifid, and each with two flowers destitute of perianth; styles, two; fruit, a compressed nut without wings. The common alder is a native of Britain and of the northern parts of Asia and America. It has roundish, wedge-shaped obtuse leaves, lobed at the margin and serrated. The bark, except in very young trees, is nearly black. It succeeds best in moist soils, and helps to secure swampy river-banks against the effects of floods. It attains a height of 30 to 60 feet. Its leaves are somewhat glutinous. The wood is of an orange-yellow color, not very good for fuel, but affording one of the best kinds of charcoal for the manufacture of gunpowder, upon which account it is often grown as coppice-wood. Great numbers of small alder-trees are used in Scotland for making staves for barrels. The wood is also employed by turners and joiners; but it is particularly valuable on account of its property of remaining for a long time under water without decay, and is therefore used for the piles of bridges, for pumps, sluices, pipes, cogs of mill-wheels, and similar purposes.

ALDERSHOTT CAMP.—When England and France declared war against Russia in 1854, in relation to Turkish affairs, the British army was known to be in an unsatisfactory state; thirty-nine years of peace had allowed many important elements in military organization to fall into a state of inefficiency. Among others, the power of acting well together in brigades and divisions had scarcely been taught to the soldiers, who had been familiar with little more than the discipline and tactics of battalions and companies. To remedy in part these defects was the object held in view in establishing the Camp at Aldershott. It was to be a permanent camp, with barracks and huts, instead of mere canvas tents; and was to be provided with all the appliances for a military school, valuable to officers as well as to privates. A dreary waste, on the confines of Surrey, Hants, and Berks, called Aldershott heath, was purchased by the government as the locality for the new camp. The area was 7063 acres, and the purchase-price about £130,000. The spot was deemed suitable as being distant from any thickly inhabited district; as being within easy reach of three or four stations on the Southwestern and Southeastern railways; and as being conveniently placed for the quick transmission of troops to any part of the southern coast. The camp was ready for the reception of troops in 1855. At first, no brick structures were attempted. The soldiers were accommodated in wooden huts, each furnishing living and sleeping room for about twenty-five men. When the camp was inaugurated, in April of the year last named, by a review at which the Queen was present, there were 18,000 troops, regulars and militia, temporarily stationed there. The huts for each regiment were grouped apart, for the better maintenance of regimental discipline. Each hut had a range of iron bedsteads on either side, capable of being doubled up; and a long table through the middle, in a line with two doors at the ends of the huts. The officers' huts, though of course superior in construction and convenience, were as simple as they could well be. The cooking was performed in huts especially set apart for that purpose, provided with efficient cooking apparatus. The wooden huts have gradually been superseded by brick barracks, at a cost of more than a quarter of a million sterling. The Basingstoke Canal, running directly across the heath, has occasioned a division into North Camp and South Camp; but each of these is susceptible of a good deal of extension. Reviews and sham fights are frequently held, at some of which the Queen has been present, and there are various important operations carried on daily, and known to very few besides those immediately concerned. There are many square miles of plain, heath, shrub, morass, valley, and hill surrounding the camp, on which soldiers, and especially the militia regiments, are exercised in the various evolutions and strategic movements connected with the battle-field and siege-works. It is no child's play; the men are often severely worked, and gain a foretaste of some of the fatigues of military life. On other days they are exercised in various quiet duties of tents and huts, barracks and kitchens, intended to teach them many of the useful knacks in which French soldiers are acknowledged to be more skilled than the English. Different regiments, regulars as well as militia, artillery as well as cavalry and infantry, take it in turn to experience camp-life at Aldershot. There are usually about from 10,000 to 15,000 troops at the camp, comprising infantry, cavalry, artillery, and militia. The Authorities some years ago purchased or leased a portion of forest-land between Aldershott and Winchester; camping arrangements of a temporary kind are made, and the troops are occasionally exercised with a tough march of a dozen miles. A thriving town has sprung up near the camp. An unfortunate circumstance is that the barracks have been built at the very edge of the ground belonging to the government; as a consequence, private speculators built beer-houses and haunts of dissipation close to the barracks, greatly to the demoralization of the soldiers; and it is not easy to buy up these people, owing to the rise in value of the land. Some alleviation has arisen from the operation of the Contagious Diseases Acts of 1866 and 1869.

ALDIONAIRE.—A sort of equerry, who in the army was kept at the expense of his master. Under Charlemagne, the *Aldionaires* were of an inferior rank.

ALEM.—The imperial standard of the Turkish Empire.

ALEMDAR.—An official who carries the green banner of Mohammed when the Sultan assists in ceremonies of solemnity.

ALERT.—In military phraseology an expression made use of to signify that an outpost has been threatened or attacked. Thus, "We have had an alert," is a military phrase. A bugle-sound is also so named, which is given by way of warning to put soldiers on their guard, and to keep them vigilant. This warning is also sounded by an outpost which may be attacked in the night, to give notice to the one that is destined to support it. The word is frequently used by old writers to express a sudden alarm caused by a merely harassing attack of the enemy.

ALEUROMETER.—An instrument invented about 1849, by M. Boland, a Parisian baker, for determining the quality of the gluten in different specimens of wheaten flour, and their consequent adaptation for bread-making. A tube of about six inches in length is divided into two parts, of which the smaller one, about two inches in length and holding a given amount of gluten, is screwed on to the longer tube, which is fitted with a piston having a graduated stem. The apparatus is then exposed to a moderate degree of heat, when the gluten expands, forcing up the piston, the amount of expansion being indicated by the distance the stem protrudes from the tube. It was found that gluten obtained from flour of good quality would expand to four or five times its original bulk, and had the smell of warm bread, while that of bad flour became viscid, with a tendency to adhere to the tube, and in some instances emitting an unpleasant odor. This instrument is indispensable to purchasing-officers of the Subsistence Department.

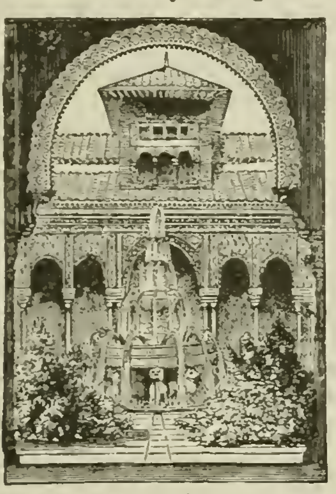
ALFERE — ALFEREZ. — Standard-bearer; ensign; cornet. The old English term for ensign; it was in use in England till the civil wars of Charles I.

ALGEBRA.—A branch of pure mathematics much used in the solution of problems of gunnery. The name is derived from the Arabs, who call the science *al-gebr wal mokâbala*—i.e., supplementing and equalizing—in reference to the transposition and reduction of the terms of an equation. Among the Italians in early times it was called *arte maggiore*, as having to do with the higher kinds of calculation, and still oftener *regola de la cosa*, because the unknown quantity was denominated *cosa*, the "thing;" hence the name of *cossike art*, given to it by early English writers. The term algebraical is generally used somewhat vaguely, to denote any expression or calculation in which signs are used to denote the operations, and letters or other symbols are put instead of numbers. But it is perhaps better to restrict the name algebra to the doctrine of equations. Literal arithmetic, then, or multiplying, dividing, etc., with letters instead of Arabic ciphers, is properly only a preparation for algebra; while analysis, in the widest sense, would embrace algebra as its first part. Algebra itself is divided into two chief branches. The first treats of equations involving unknown quantities having a determinate value; in the other, called the diophantine or indeterminate analysis, the unknown quantities have no exactly fixed values, but depend in some degree upon assumption.

ALGER BREECH-LOADER.—A substitute for the Armstrong vent-piece, which must be lifted out of its seat. It consists of a cross-plug forming a continuation of the bore when the handle is vertical, and closes the bore, being set up firmly by the breech-screw, when the handle is horizontal. A suitable gas-check might be placed through the hollow screw, in a recess in the cross-plug, by revolving the latter through half a circle.

ALGHISI-DI-CARPI SYSTEM OF FORTIFICATION.—In this system the curtain forms a tenaille; the main ditch encloses a flat space, and the bastions are small, having orillons and casemated flanks, with a cavalier inside the gorge. See *Fortification*.

ALHAMBRA.—The name given to the fortress which forms a sort of acropolis or citadel to the city of Granada, and in which stood the palace of the ancient Moorish Kings of Granada. The name is a corruption of the Arabic *Kal-'at al hamra*, "the red castle." It is surrounded by a strong wall, more than



Entrance to the Court of the Lions—Alhambra.

a mile in circuit, and studded with towers. The towers on the north wall, which is defended by nature, were used as residences connected with the palace. One of them contains the famous *Hall of the Ambassadors*. The remains of the Moorish Palace are called by the Spaniards the Casa Real. It was begun by Ibnu-l-ahmar, and continued by his successors, 1248–1348. The portions still standing are ranged round two oblong courts, one called the *Court of the Fish-pond*, the other the *Court of the Lions*. They consist of porticos, pillared halls, cool chambers, small gardens, fountains, mosaic pavements, etc. The lightness and elegance of the columns and arches, and the richness of the ornamentation, are unsurpassed. The coloring is but little altered by time. The most characteristic parts of the Casa Real have been reproduced in the "Alhambra Court" of the crystal palace at Sydenham. A great part of the ancient palace was removed to make way for the palace begun by Charles V., but never finished. It is long since any part of the Moorish Palace was inhabited; but it is kept in a state of preservation as a work of art, and as a memorial of the tragic legend of the Abencerrages.

ALI BEY.—A Colonel of Turkish Cavalry; also the rank of a District Commander.

ALIBI.—A defence resorted to in criminal prosecutions, when the party accused, in order to prove that he could not have committed the crime with which he is charged, tenders evidence to the effect that he was in a different place at the time the offence was committed. When true, there can be no better proof of innocence; but as offering the readiest and most obvious opportunity for false evidence, it is always regarded with suspicion. In the case of crimes the place of committing which is immaterial—as, for example, the act of fabricating the plates, or of throwing off the spurious notes, in a case of forgery—a proof of *alibi* is of no avail.

ALIDADE.—The movable arm of a graduated instrument carrying sights or a telescope, by which an angle is measured from a base-line observed through the stationary or level line of sights. It is used in plane tables, theodolites, astrolabes, demi-circles, and numerous other angulometers. Four varieties of the Alidade are in common use. The simplest Alidade consists of a brass rule or straight-edge, twenty inches long and two to three inches wide, at the ends of which are screwed sight-vanes, like those of the ordinary compass; the edge of the rule being chamfered and in line with the slots of the vanes. To another form of simple Alidade is fitted the telescopic sight, having a level, clamp and tangent, and vertical circle reading to five minutes, attached to the telescope, which is also supplied with micrometer wires. The telescope is placed in line with the straight-edge as before. Another style of Alidade is shown in the article "Plane Table," the brass rule being now two inches wide, except where it is expanded one third from the end to receive the base of the column. The column supports the telescope with its attachments, the vertical circle being divided on silver and reading to single minutes. The telescope is nine inches long, of a power of 20 diameters, provided with stadia, and adjusted and used like that of the Transit; it is also in line with the chamfered edge of the rule. In another form of Alidade, the telescope is precisely the same as that used on the best Transits, being also supplied with level, clamp and tangent, vertical circle on silver reading to single minutes, and micrometer wires for measuring distances. It is placed on the brass rule precisely like that of the one last described, and is adjusted and used in the same manner. In using the plane table the tripod is set up firmly, and the table covered with paper, placed upon the flange of the socket, and secured by the screws, *e e;* the nut, *d*, being now loosened, the table is moved by the pressure of the hand on different parts of the board, until the levels on the plate will come into the centre on any part of the table. The nut, *d*, is then screwed up and the table made firm; any place on the paper can then be assumed as the starting-point, its position over a given point on the ground being determined by the plumbing-bar and plummet. From the given point on the paper, sights can then be taken to different corners of the field, and lines drawn on the paper along the edge of the Alidade, and thus a miniature of the tract be traced on the paper, the bearing of any line being ascertained by applying the side of the compass-plate to the edge of the Alidade placed on that line. The table can be moved horizontally either by hand on releasing the screws, *e e*, or by a tangent-screw. See *Plane Table* and *Theodolite*.

ALIEN.—The citizen of one State, when resident in another, unless naturalized, is an alien. The condition of an alien does not necessarily result from foreign birth. The son of a natural-born or naturalized Englishman is not an alien, wherever he may be born. This privilege even extends to the second generation on the father's side; and thus a man whose paternal grandfather was an Englishman is an Englishman himself, unless either his father or grandfather be liable to the penalties of felony, have been attainted of treason, or be serving in the army of a Prince at war with England, at the period of his birth. Neither is this privilege affected by the fact that the mothers of such persons were foreigners. The children of aliens born in England, except in the case of a hostile invasion, are natural-born subjects; but the children of Englishwomen by aliens are aliens, unless born within the British dominions. The allegiance due by an alien or stranger to the Prince in whose dominions he resides is usually called *local* or *temporary allegiance*. It differs from natural allegiance chiefly in this, that whereas natural allegiance is perpetual and unaffected by change of residence, local allegiance ceases when the stranger transfers himself to another kingdom.

ALIGNMENT.—A term used in military tactics, equivalent to *in line*. Thus, the alignment of a battalion is effected when the men are drawn up in line; the alignment of a camp is a rectilinear arrangement of the tents according to some prearranged plan. The instructor first teaches the recruits to align themselves man by man, the better to comprehend the principles of alignment; to this end, he advances the two men on the right three or more yards, and having aligned them, commands: (1) *By file*, (2) *Right* (or *left*), (3) DRESS, (4) FRONT. At the command, *dress*, the recruits move up successively, in quick time, shortening the last step so as to find themselves about six inches behind the alignment; each recruit then moves on the line, which must never be passed, taking steps of two or three inches, casting his eyes to the right so as to see the coat-buttons of the second man from him, keeping his shoulders square to the front, and touching with his elbow that of the man on the right without opening his arms. At the command, *front*, given when the rank is well aligned, the recruits cast their eyes to the front and remain firm. The recruits having learned to align themselves man by man, the instructor next aligns the squad by the commands, (1) *Right* (or *left*), (2) DRESS, (3) FRONT. At the command, *dress*, the entire rank, except the men established as a basis, moves forward, and dresses up to the line, as previously explained. The instructor verifies the alignment by placing himself outside the right flank, and orders forward or back such files as may be in rear or in advance of the line; this done, he commands, *front*. Alignments to the rear are executed on the same principles, the recruits stepping back a little beyond the line, and then dressing up, by short steps of two or three inches. The comands are: (1) *By file, right* (or *left*) *backward*, (2) DRESS, (3) FRONT; or, (1) *Right* (or *left*) *backward*, (2) DRESS, (3) FRONT.

ALKALIES.—The word *alkali* is of Arabic origin, *kali* being the name of the plant from the ashes of which an alkaline substance was first procured. The name now denotes a class of substances having similar properties. The alkalies proper are four in number—potash, soda, lithia, and ammonia. The first three are oxides of metals; the last is a compound of nitrogen, hydrogen, and oxygen, and, being in the form of a gas, is called the volatile alkali. Potash, being largely present in the ashes of plants, is called the vegetable alkali; and soda, predominating in the mineral kingdom, is designated the mineral alkali. The *alkaline earths*, as they are called—lime, magnesia, baryta, and strontia—are distinguished from the former by their carbonates not being soluble in water. The distinguishing property of alkalies is that of turning vegetable blues green, and vegetable yellows reddish brown. Blues reddened by an acid are restored by an alkali. The alkalies have great affinity for acids, and combine with them, forming salts, in which the peculiar qualities of both alkali and acid are generally destroyed; hence they are said to neutralize one another. In a pure state alkalies are extremely caustic, and act as corrosive poisons. Combined with carbonic acid, especially as bicarbonates, they are used to correct acidity in the stomach; but the injudicious and continued use of them is attended with great evil.

ALLECRET—ALLECRETE.—Light armor used by both cavalry and infantry in the sixteenth century, especially by the Swiss. It consisted of a breast-plate and gussets, often reaching to the middle of the thigh, and sometimes below the knees.

ALLECTI MILITES.—A name given by the Romans to a body of men who were drafted for military service.

ALLEGIANCE.—It is but recently that foreign governments have come to recognize the right of persons to change their allegiance as well as their residence. The United States always held it to be a natural right, and our legislation so recognizes it. The difference was strikingly manifest in the War of 1812, when the Prince Regent proclaimed that every native-born Briton taken prisoner while fighting for the Americans should be shot for treason, to which President Madison replied that if any naturalized American of the United States should suffer death in such manner he would execute two British prisoners. There were no executions of the sort which England had threatened. Very recently the question has been discussed as to the right of a government to subject to military service men who were once its citizens but were afterwards citizens of another country; and late decisions tend to show that most governments are abandoning the old claim, "once a citizen always a citizen." For instance, Germans naturalized in the United States on returning to Germany were formerly required to enter the army; but now they plead American citizenship, and with success. Allegiance is often transferred *en masse*, as on the treaty of peace in 1783, when British subjects who should so elect became Americans; also, when Louisiana and Florida were purchased and Texas was annexed; no inquiry was made about allegiance, but the official transfer made the Creoles and the Texans as completely citizens owing allegiance as though born under the United States flag. The law of Congress, July, 1868, very clearly sets forth the extent and obligations of allegiance. The preamble states that the right of expatriation is natural and inherent in all people and indispensable to the enjoyment of rights to life, liberty, and the pursuit of happiness; that, recognizing this right, our government has received emigrants from all nations and given them citizenship and protection; that it is necessary for the maintenance of public peace that the claim of foreign allegiance as to such adopted citizens should be promptly and firmly disavowed; and therefore it was enacted that any declaration, opinion, order, or decision of any officer of this government which denies, impairs, restricts, or questions the right of expatriation is inconsistent with the fundamental principles of the government; that all naturalized citizens of the United States, while in Foreign States, are entitled to, and shall receive from this government, the same protection of person and property that is accorded to native-born citizens in like circumstances. This broad declaration of our rights and duties was followed in May, 1870, by the British Parliament in an act revising all British laws on alienage, expatriation, and naturalization—the government for the first time recognizing the right of subjects to renounce allegiance to the Crown.

ALLEN BRAKE.—A contrivance for checking violent recoil. It consists of a wooden wedge, shod with iron, attached to the bracket immediately in rear of the truck by jointed bars of iron, the upper of which are bolted to the bracket, while from the joint another bar passes horizontally through the axle-tree arm, forming the linch-pin. The wedge rests upon the ground in rear of the truck, following it as the carriage is run up, but on recoil the truck overtakes and rides upon the wedge. A rope-lanyard is attached to the wedge and an iron cleat upon the side of the carriage, so that, if it is wished not to use the brake, the wedge can be secured so as not to come into action on recoil. See *Brake*.

ALLEZOIR.—A frame of timber firmly suspended in the air with strong cordage, on which is placed a piece of ordnance with the muzzle downwards. In this situation the bore is rounded and enlarged by means of an instrument which has a very sharp and strong edge made to traverse the bore by force of machinery or horses, and in a horizontal direction.

ALLEZURES.—The metal taken from cannon and other guns by boring.

ALLIAGE.—A term used by the French to denote the composition of metals used for the fabrication of cannon, mortars, etc.

ALLIANCE.—In a military sense, a treaty entered into by Sovereign States for their mutual safety and defence. In this sense, alliances may be divided into such as are offensive, where the contracting parties oblige themselves jointly to attack some other power; and into such as are defensive, whereby the contracting powers bind themselves to stand by and defend one another in case of being attacked by any other power. Alliances are variously distinguished according to their object, the parties in them, etc. Hence we read of equal, unequal, triple, quadruple, grand, offensive, defensive alliances, etc. See *Treaty*.

ALLIGATI.—A name given by the Romans to prisoners of war and their captors. A chain was attached to the right wrist of the prisoner and the left wrist of the warrior who captured him.

ALLOCUTIO.—An oration addressed by a Roman General to his soldiers to animate them to fight, to appease sedition, or to keep them to their duty.

ALLODIAL.—Independent; not feudal. The Allodii of the Romans were bodies of men employed in any emergency, in a manner similar to our volunteer associations.

ALLONGE.—A pass or thrust with a rapier or small sword, frequently contracted into *lunge;* also a long rein used in the exercising of horses.

ALLOWANCE.—Money granted in addition to the regular pay of an officer or soldier for some particular purpose, or to a regiment to meet certain expenses. For instance, what is termed *Colonel's Allowance* is granted to General Officers in the British army when selected by the Commander-in-Chief to fill the post of "Colonel of a Regiment"; this takes place when vacancies by death occur. In the Indian Staff Corps the Colonel's Allowance is granted to each officer after a stated period, viz., thirty-eight years' service, provided he has served twelve years in the rank of Lieutenant-Colonel. *Lodging Allowance* is granted to Officers, Non-commissioned Officers, and men, when accommodation cannot be provided for them in barracks; it includes *fuel* and *light allowance*. The two latter allowances are granted to Officers, irrespective of Lodging Allowance. Agreeably to a late warrant, the allowance granted to Non-commissioned Officers has been fixed as follows: Class I., 1*s.* 9*d.* a day; Class II., 1*s.* a day; Class III., 6*d.* a day. A Non-commissioned Officer on the married roll continues to receive lodging, fuel, and light allowance for the benefit of his wife and family when he may be in hospital or temporarily separated from them, on service, provided no married soldiers' quarters become available for their use. *Horse Allowance* is granted to Officers when forage has not been issued by the Commissariat. *Contingent Allowance* is granted for any particular expenditure permitted by the regulations. *Servants' Allowance* is given to certain Officers who are not allowed soldier-servants. *Field Allowance* is passed to Officers to enable them to provide themselves with baggage-animals and equipment in the field. The term *Allowance* is also applied to the amount of rations, forage, etc., served out periodically to any one man or to a body of men. See *Allowances*.

ALLOWANCE OF QUARTERS.—In the United States army, in allotment of quarters, officers have choice according to rank, but the Commanding Officer may direct the officers to be lodged convenient to their troops. An officer may select quarters occupied by a junior; but, having made his choice, he must abide by it, and cannot again at the post displace a junior, unless himself displaced by a senior. The set of rooms to each quarters will be assigned by the Quartermaster, under the direction of the Commanding Officer; attics are not counted as rooms. Officers cannot choose rooms in different sets of quarters. The following table shows the number of rooms, the quantity of fuel, and the allowance or cooking and heating stoves to be supplied for the use of officers in Public Quarters and Barracks:

	Rooms			Cords of wood per month.		Increased allowance from Sept. to April, both inclusive		For quarters.		For office
	As quarters	As kitchen.	As office.	From May 1 to Aug 31.	From Sept 1 to April 30.	Between 36th and 43d deg. N. latitude one fourth.	North of 43d deg one third.	Heating-stoves.	Cooking-stoves or ranges	Heating-stoves.
The General (allowed by law for quarters and fuel, $125 per month).										
The Lieutenant-General or a Major-General	5	1	Variable	1	5	1¼	1⅔	5	1	Variable.
A Brigadier-General or Colonel	4	1		1	4	1	1⅓	4	1	
A Lieutenant-Colonel or Major	3	1		1	3½	⅞	1⅙	3	1	
A Captain or Chaplain	2	1		¾	3	¾	1	2	1	
A Lieutenant	1	1		½	2	½	⅔	1	1	

ALLOWANCES.—In the British army—and to various degrees in the armies of other countries—military officers, besides their recognized pay, receive certain allowances for special duties or when placed under exceptional circumstances. Without detailing the actual amount of these allowances, it may be well to enumerate the principal modes in which they arise. An officer commanding and paying a troop or company receives a contingent allowance as an indemnification for the expense of repairing arms, swords, and scabbards; for burials; and for the debts of soldiers who become non-effective. A kind of general average is struck for the probable amount of these charges. An officer on duty in the United Kingdom, in a situation entitling him to be lodged at the public expense, and whose lodging is not otherwise paid for by the public, receives an allowance as "lodging-money," varying in amount according to his rank. An officer marching with troops in the United Kingdom, on a route determined by competent authority, if unable to mess with his regiment or detachment on a particular day, receives an allowance in compensation. An officer sent on permanent or temporary duty from one place to another receives a travelling allowance of so much per mile. An officer serving on a court-martial receives an allowance of so much per day, besides a travelling allowance if the place be distant. An officer temporarily detached on duty, where he cannot join his regimental mess, has an allowance for mess-money. Besides those here enumerated, there are allowances for detention at ports of embarkation, etc., and others of a minor kind. See *Allowance* and *Mileage*.

ALLOY.—A mixture of two or more metals, either natural, or produced artificially by melting them together. The mixture has often different properties from the component metals, and bears a distinct name. Thus, bell-metal is an alloy of copper and tin; tombak, of copper and zinc; brass, of copper with a larger proportion of zinc, etc. Alloys are generally harder than the metals that compose them, and this is the motive for alloying the precious metals. Alloys seldom possess the density which theory or calculation from the specific gravity of their constituents would indicate. Thus, many alloys possess a greater density than the mean density of their constituents, while others have a less density. The increase in density of the alloy indicates that the metals have contracted: in other words, that the metallic molecules have approached each other more closely; while the decrease in density denotes a separation of the molecules to greater distances from each other.

ALLOYS which exhibit a greater density than the mean density of the metals composing them.	ALLOYS which possess a less density than the mean density of the metals composing them.
Gold and zinc.	Gold and silver.
" " tin.	" " iron.
" " bismuth.	" " lead.
" " antimony.	" " copper.
" " cobalt.	" " iridium.
Silver " zinc.	" " nickel.
" " tin.	Silver " copper.
" " bismuth.	Iron " bismuth.
" " antimony.	" " antimony.
Copper " zinc.	" " lead.
" " tin.	Tin " lead.
" " palladium.	" " palladium.
" " bismuth.	" " antimony.
Lead " antimony.	Nickel " silver.
Platinum and molybdenum.	Zinc " antimony.
Palladium and bismuth.	

The strength or cohesion of an alloy is generally greater than that of the mean cohesion of the metals contained therein, or even of that of the most cohesive of its constituents. Thus, the breaking weight of a bar of copper or tin (meaning the longitudinal strain it can bear) is very much lower than the breaking weight of a bar composed of an alloy of tin and copper. The following table represents the

COHESION OF METALS.

	Bar 1 in. square breaks with lbs.		Bar 1 in. square breaks with lbs.
Barbary copper....	22,570	Malacca tin	3,211
Japan "	22,570	Bismuth..........	3,008
English black tin..	20,272	Zinc..............	2,689
" tin-plate...	6,650	Antimony	1,060
Banca tin.........	3,679	Lead	885

When any two of the above metals combine together, they generally—though not always—yield an alloy which is much stronger than we should expect; thus the

COHESION OF ALLOYS.

	Bar 1 in. square yields with lbs.
10 parts of copper and 1 part of tin...........	32,093
8 " " 1 " "	36,088
6 " " 1 " "	44,071
4 " " 1 " "	35,739
2 " " 1 " "	1,017
1 " " 1 " "	725
4 " English tin and 1 " lead..........	10,607
4 " banca " " 1 " antimony.....	13,480
4 " " " " 1 " bismuth	16,692
4 " English tin " 1 " zinc....... ..	10,258
4 " " " " 1 " antimony.....	11,323

The power of conducting electrical currents is not so great in an alloy as the mean conducting power of its components. The composition of the more commonly occurring and commercially important alloys is as follows: Plumber's solder, 1 tin and 2 lead; soft solder, 2 tin and 1 lead; common pewter, 4 tin and 1 lead; gun-metal, 9 copper and 1 tin; bronze, 9 copper and 1 tin and zinc; cymbals and Chinese gongs, 4 copper and 1 tin; bell-metal, 3 copper and 1 tin; speculum-metal, 2 copper and 1 tin; pot-metal or cock-metal, 2 copper and 1 lead; gilding-metal, 16 copper and 1 to 1¼ zinc; Mannheim gold—pinchbeck or bath-metal, 16 copper and 4 zinc; Bristol brass, for soldering, 16 copper and 6 zinc; ordinary brass, for casting, 16 copper and 8 zinc; Muntz sheathing-metal, 16 copper and 10⅔ zinc; spelter-solder for copper and iron, 16 copper and 12 zinc; spelter-solder for brass-work, 16 copper and 16 zinc; Mosaic gold, 16 copper and 16½ zinc; hardest silver-solder, 4 silver and 1 copper; hard silver-solder, 3 silver and 1 copper; soft silver-solder, 2 silver and 1 copper; German silver, 100 copper, 60 zinc, and 40 nickel; type-metal, ordinary, 15 lead, 4 antimony, and 1 tin, or 14 lead, 5 antimony, and 1 tin—small types, 4 lead and 1 antimony—large types, 6 lead and 1 antimony; stereotype-metal, 48 lead, 6 antimony, and 1 tin; Britannia metal, 50 tin, 4 antimony, 4 bismuth, and 1 copper.

ALLUMELLE.—A thin and slender sword which was used in the Middle Ages to pierce the weak parts or joints of armor.

ALLY.—A term implying, in a military sense, any nation united to another under a treaty either offensive or defensive, or both.

ALMADIE.—A kind of military canoe or small vessel, about 25 feet long, made of the bark of a tree, and used by the negroes of Africa. *Almadie* is also the name of a long boat used at Calcutta, often from 80 to 100 feet long, and generally 6 or 7 broad; they are rowed with from 10 to 30 oars.

ALMAN-RIVETS.—A sort of light armor derived from Germany, characterized by overlapping plates which were arranged to slide on rivets, by means of which flexibility and ease of movement were promoted.

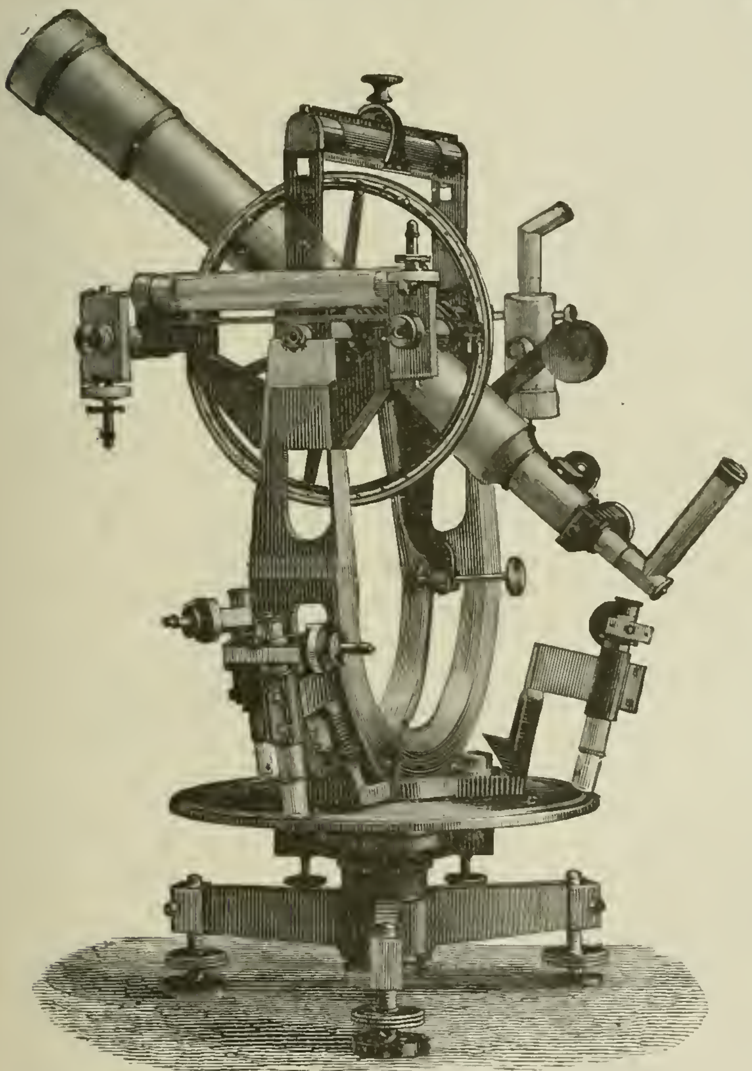
ALTISCOPE.—An invention consisting of an arrangement of lenses and mirrors in a vertical telescope-tube, by means of which a person is able to overlook objects intervening between himself and the object he desires to see. When the sections of the tube are extended, the view is received upon an upper mirror placed at an angle of 45°, and reflected thence down the tube to a lower mirror, where it is seen by the observer. The image is magnified by lenses intervening between the mirrors. The telescopic tubes are so connected that each in turn acts upon the next in the series, as it comes to the end of its own range, and thus the desired elevation is arrived at. The means of extension are a winch and cords.

This contrivance affords a means for training guns to a given angle with the axis of the vessel, or on an object, while the gunner remains beneath the deck. There is attached beneath the deck, to the pintle of the pivoted gun, a graduated index-plate, by which its horizontal bearing may be read. A telescopic tube, with two rectangular bends and with reflecting mirrors at the angles, is so placed as to be used from beneath the deck; two of these may be so situated as to form a base of sufficient length to obtain, by simultaneous observation, the distance by triangulation. The upper and lower limbs of the telescopic tube are parallel; the upper one is presented towards the object, the other to the eye. The image of the object after being twice reflected reaches the eye of the observer, whose person is not exposed.

ALTITUDE AND AZIMUTH INSTRUMENT.—Altitude, in astronomy, is the height of a heavenly body above the horizon. It is measured, not by linear distance, but by the angle which a line drawn from the eye to the heavenly body makes with the horizontal line, or by the arc of a vertical circle intercepted between the body and the horizon. Altitudes are taken in observatories by means of a telescope attached to a graduated circle which is fixed vertically. The telescope being directed towards the body to be observed, the angle which it makes with the horizon is read off the graduated circle. The Altitude thus observed must receive various corrections—the chief being for parallax and refraction—in order to get the true Altitude. At sea, the Altitude is taken by means of a sextant, and then it has further to be corrected for the dip of the visible horizon below the true horizon. The correct determination of Altitudes is of great importance in most of the problems of astronomy and navigation.

The Azimuth of a heavenly body is the angle measured along the horizon between the North or South point and the point where a circle, passing through the zenith and the body, cuts the horizon. The word comes from the Arabic, and is said to be derived from a word signifying a quarter of the heavens. It is usual to measure the Azimuth westward from the point most remote from the elevated pole, beginning at 0° and returning to it at 360°. Thus, in northern latitudes, where the north pole is elevated, the Azimuth is measured from the south point, so that the east point, for instance, has an Azimuth of 270°. Azimuth circles are those which extend from zenith to nadir, cutting the horizon at right angles, or those in which all the points have the same Azimuth.

An Altitude and Azimuth Instrument consists essentially of a vertical circle with its telescope so arranged as to be capable of being turned round horizontally to any point of the compass. It thus differs from a Transit Instrument, which is fixed in the meridian. The drawing represents one of these instruments, made by Fauth & Co., which was on exhibition in the International Exhibition at Philadelphia. It is of superior construction, and differs from other instruments of this class in many important particulars. Although not a "repeating instrument," strictly speaking, and, therefore, not liable to the defects inherent to repeaters, yet both the horizontal and vertical circles can be shifted for position, so as to bring a different part of the graduation under the microscopes. The circles are divided on silver into five-minute spaces, reading by micrometer microscopes to single seconds. The standards radiate out from the centre, and are high enough to let the telescope swing through. The pivots of the telescope axis rest on agate, and are made of phosphor-bronze; a delicate striding level, reading to seconds, over the pivots, is provided; illumination through pivots; the horizontality of the microscopes for the vertical circle is controlled by a chambered level reading to seconds. Both circles are entirely free of clamps and tangent screws, these being attached to a collar, so as not to produce any strain. — See *Theodolite* and *Transit Instrument*.



From Gebbie & Barrie's "Masterpieces of the U. S. International Exhibition, 1876."

ALUM.—A whitish, astringent, saline substance; properly it is a double salt, being composed of sulphate of potash and sulphate of alumina, which, along with a certain proportion of water, crystallize together in octahedrons or in cubes. Its formula is $KOSO_3 + Al_2O_33SO_3 + 24HO$. Alum is soluble in eighteen times its weight of cold water, and in its own weight of hot water. The solution thus obtained has a peculiar astringent taste, and is strongly acid to colored test-papers. When heated, the crystals melt in their water of crystallization; and when the water is completely driven off by heat, there is left a spongy white mass, called burnt or anhydrous alum. Alum is much used as a mordant in dyeing. This property it owes to the alumina in it, which has a strong attachment for textile tissues, and also for coloring matters; the alumina thus becomes the means of fixing the color in the cloth. The manufacture of the colors or paints called lakes depends on this property of alumina to attach to itself certain coloring matters. Alum is also used in the preparation of leather from skins, and, in medicine, as a powerful astringent for arresting bleeding and mucous discharges. Its use in the making of bread, to give a white appearance and more pleasing consistence to bread made from indifferent flour, is highly objectionable. The potash in alum can be replaced partly or altogether by soda or ammonia; the alumina by oxide of chromium or sesquioxide of manganese; or the sulphuric acid by chromic acid or peroxide of iron, without altering the form of the crystals. There are thus soda, ammonia, chrome, etc., alums, forming a genus of salts of which common alum is only one of the species. The more important members of the class, expressed in symbols, are:

$KOSO_3 + Al_2O_3 3SO_3 + 24HO$, potash alum.

$NaOSO_3 + Al_2O_3 2SO_3 + 24HO$, soda alum.

$NH_4OSO_3 + Al_2O_3 3SO_3 + 24HO$, ammonia alum.

$KOSO_3 + Cr_2O_3 3SO_3 + 24HO$, chromic potash alum.

$FeOSO_3 + Al_2O_3 3SO_3 + 24HO$, ferrous alum.

ALUMINIUM.—A white metal, somewhat resembling silver, but possessing a bluish hue which reminds one of zinc. It is very malleable and ductile, in tenacity it approaches iron, and it takes a high polish. When heated in a furnace, it fuses, and can then be cast in moulds into ingots. Exposed to dry or moist air, it is unalterable, and does not oxidize as lead and zinc do. Cold water has certainly no action upon it, and in the majority of experiments hot water has not sensibly affected it. Sulphuretted hydrogen, the gas which so readily tarnishes the silver in households, forming a black film on the surface, does not act on aluminium, which is found to preserve its appearance under all ordinary circumstances as perfectly as gold does. When fused and cast into moulds, it is a soft metal like pure silver, and has a density of 2.56; but when hammered or rolled it becomes as hard as iron, and its density increases to 2.67. It is therefore a very light metal, being lighter than glass, and only one fourth as heavy as silver. This property was taken advantage of by Napoleon III., who ordered the eagles surmounting the standards of the French army to be made of aluminium instead of silver; and thus the same-sized eagle was reduced to one fourth of its former weight. Aluminium is very sonorous; and when a rod or small bell made of it is struck, it gives out a very sweet, clear, ringing sound. Aluminium forms with copper several light, very hard, white alloys; also a yellow alloy, which, though much lighter than gold, is very similar to it in color. By itself, aluminium is used for jewelry, small statuettes, and other works of art. It is also employed for the tubes of field-glasses Its bluish color can be whitened by hydrofluoric and phosphoric acids, and also by a heated solution of potash. On the whole, considering its valuable properties, this metal has not received such extensive application in the arts as might have been expected.

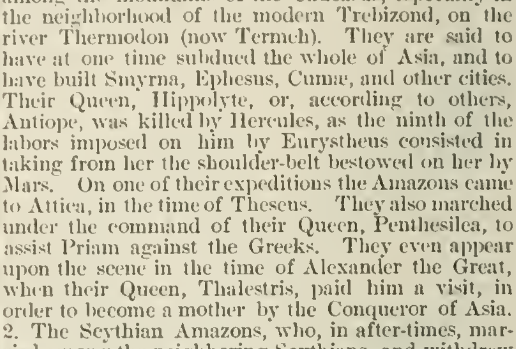
ALUMINIUM-BRONZE.—An alloy of copper and aluminium, having great strength and hardness. See *Cannon-Metals*.

ALUM-LEATHER.—A leather much used in the Armory, tanned by a composition of alum and salt. Three pounds of salt and four of alum are used to one hundred and twenty middle-sized skins, which are placed in a tumbling-box with a sufficient quantity of water, and treated in the usual manner. Alum was first used as a tanning agent by the Saracens.

ALURE.—An old term for the gutter or drain along a battlement or parapet wall.

AMAZONS.—According to a very ancient tradition, the Amazons were a nation of women, who suffered no men to remain among them, but marched to battle under the command of their Queen, and formed for a long time a formidable State. They held occasional intercourse with the men of the neighboring States. If boys were born to them, they either sent them to their fathers, or killed them. But they brought up the girls for war, and burned off their right breasts, that they might not be prevented from bending the bow. From this custom they received the name of Amazons; that is, "breastless." Such is the ordinary tale; the origin of which is perhaps to be accounted for by supposing that vague reports, exaggerated and poetically embellished, had reached the Greeks of the peculiar way in which the women of various Caucasian districts lived, performing military duties which elsewhere devolved on husbands, and also of the numerous examples of female heroism which, travellers inform us, still distinguish the women of that region. In later times, however, the word Amazon has been supposed to have some connection with the Circassian word "Maza," signifying the moon, as if the myth of the Amazons had taken its origin in the worship of the moon, which prevailed on the borders of Asia. Three nations of Amazons have been mentioned by the ancients. 1. The Asiatic Amazons, from whom the others branched off. These dwelt on the shores of the Black Sea, and among the mountains of the Caucasus, especially in the neighborhood of the modern Trebizond, on the river Thermodon (now Termeh). They are said to have at one time subdued the whole of Asia, and to have built Smyrna, Ephesus, Cumæ, and other cities. Their Queen, Hippolyte, or, according to others, Antiope, was killed by Hercules, as the ninth of the labors imposed on him by Eurystheus consisted in taking from her the shoulder-belt bestowed on her by Mars. On one of their expeditions the Amazons came to Attica, in the time of Theseus. They also marched under the command of their Queen, Penthesilea, to assist Priam against the Greeks. They even appear upon the scene in the time of Alexander the Great, when their Queen, Thalestris, paid him a visit, in order to become a mother by the Conqueror of Asia. 2. The Scythian Amazons, who, in after-times, married among the neighboring Scythians, and withdrew further into Sarmatia. 3. The African Amazons, who, under the command of their Queen, Myrina, subdued the Gorgons and Atlantes, marched through Egypt and Arabia, and founded their capital on the lake Tritonis, but were then annihilated by Hercules.

AMBULANCE.—A military term which is somewhat differently applied in different countries. In France, an ambulance is a portable hospital, one of



which is attached to every division of an army in the field, and provided with all the requisites for the medical succor of sick and wounded troops. Such an ambulance is stationed at some spot removed from immediate danger; and soldiers are sedulously employed after a battle in seeking out those who have fallen, and conveying them to the ambulance. Baron Larrey, during the great wars of the first Napoleon, brought this department of medical business to a high degree of efficiency, and set an example to the rest of Europe. When England engaged in war with Russia in 1854, the ambulance arrangements, like many others relating to the army, were in a very imperfect state. In the English army, ambulance, strictly speaking, means a field-hospital with all its wagons, litters, tents, cooking-canteen, etc.; but sometimes the name is applied to a four-wheeled wagon or a two-wheeled cart fitted up for the reception of wounded men. When Lord Raglan was about to be sent out with the army, Dr. Guthrie, President of the College of Surgeons, devised a new form of ambulance-cart; while Dr. Andrew Smith, Director-General of the Army and Ordnance Medical Department, invented a new ambulance-wagon. In the Guthrie cart, the badly wounded were laid on it at full length, while those slightly hurt sat in front and rear and on the sides. A stretcher was slung from the top for the accommodation of the former. The back-board was let down for cases requiring amputation. The hospital-chests were lashed underneath. After the battle of the Alma, the English were almost entirely destitute of means for conveying their wounded down to the beach; but the French had for this purpose a large number of *cacolets*, suggested to them by their experience in Algeria. Each of these consists of two easy-chairs, slung, like panniers, across the back of a mule, as shown in the drawing on page 40. These were especially available along tracks where no wheel-carriage could pass. These cacolets have since been adopted in the English army, as well as improved hand-litters, wheeled litters, or barrows, and ambulance-wagons on a more modern model than those of Smith and Guthrie, but having the same general character. The American war, the wars of 1866 and '70, and, above all, the growth of volunteer aid-societies under the influence of the Geneva Convention of 1866 (which gave to the wounded and their attendants the privileges of neutrality), have largely developed the ambulance equipments of every European army. Every international exhibition now contains an immense number of designs for the safe transport of the wounded. The most remarkable step taken in this direction has been the organization of railway ambulances. Trains of carriages either built for the purpose, or adapted from the ordinary rolling-stock, can now be fitted up as moving hospitals, with their staff of surgeons and attendants; and by means of these railway ambulances the wounded can be safely and rapidly removed from the encumbered field-hospitals to the permanent hospitals of the great cities of their own country. All the fittings for thus adapting railway trains to hospital purposes are now kept permanently in store in many of the countries of the Continent.

The following are the rules for a uniform system of ambulances in the armies of the United States: The Medical Director, or chief Medical officer, of each army corps shall, under the control of the Medical Director of the army to which such army corps belongs, have the direction and supervision of all ambulances, medicine and other wagons, horses, mules, harness, and other fixtures appertaining thereto, and of all officers and men who may be detailed or employed to assist him in the management thereof, in the army corps in which he may be serving. The Commanding Officer of each army corps shall detail officers and enlisted men for service in its ambulance corps upon the following basis, viz.: One Captain, who shall be Commandant of said ambulance corps; one First Lieutenant for each division; one Second Lieutenant for each brigade; one Sergeant for each regiment; three privates for each ambulance, and one private for each wagon. The officers and non-commissioned officers of the ambulance corps shall be mounted. The officers, non-commissioned officers, and privates detailed for each army corps shall be examined by a board of Medical officers of the same as to their fitness. Such as are found to be not qualified shall be rejected, and others detailed in their stead. There shall be allowed and furnished to each army corps two-horse ambulances, upon the following basis: Three to each regiment of Infantry of five hundred men or more; two to each regiment of Infantry of more than two hundred and less than five hundred men; and one to each regiment of Infantry of less than two hundred men; two to each regiment of Cavalry of five hundred men or more; and one to each regiment of Cavalry of less than five hundred men; one to each battery of Artillery, to which it shall be permanently attached; to the headquarters of each army corps, two such ambulances; and to each division train of ambulances two army-wagons. Ambulances shall be allowed and furnished upon the same basis to divisions, brigades, and commands not attached to any army corps. Each ambulance shall be provided with such number of stretchers and other appliances as shall be prescribed by the Surgeon-General.

During the late war in America, much attention was given to the subject of ambulances, and many forms were proposed possessing merit, as was demonstrated by their successful use in the Franco-German war of 1870. The drawing shows a form of ambulance used in the United States with satisfaction. The two stretchers shown are detachable, and may be placed inside the wagon when moving over level roads, or may be removed and transported by men when moving over rough and rocky country, or when it becomes necessary to take the wagons apart in

order to get them up or down very steep places. The stretchers are so constructed with hinges and hooks as to be folded into a very small space when not needed, and to permit the supports to be used as handles. In the United States service, litters are adopted or authorized by the Secretary of War, in lieu of ambulances, when judged necessary, under such rules and regulations as may be prescribed by the Medical Director of each army corps. See *Guthrie Ambulance-cart*.

AMBULANCE CORPS.—A body of men usually unknown in peace-time, but formed on the outbreak of war to attend upon the sick and wounded. The *personnel* of such a body in England would be taken from the Army Hospital Corps; and the ambulance carriages attached to the transport would form the *matériel*.

AMBULATOR.—An instrument, sometimes called Perambulator, for measuring distances. The term is often erroneously applied to a velocipede and to a traction engine, whose mode of propulsion is by oscillating bars whose feet come in contact with the ground in somewhat similar manner to the natural action of the legs of animals or of man. See *Odometer*.

AMBUSCADE.—In planning an ambuscade, we should be well acquainted with the enemy's force, and the state of discipline shown by it. The position chosen for the attempt must be favorable to the concealment of troops, and if practicable it should be reached by night, every precaution being taken to insure secrecy. The best positions are those where the enemy is enclosed in a defile or village and has not taken the proper precautions to secure himself from an attack. By seizing the outlets of the defile by infantry, in such cases, and making an impetuous charge of cavalry into it, the enemy may be completely routed. Ambuscades may frequently be attempted with success in the affairs of advanced- and rear-guards; by pushing the enemy vigorously and then falling back, if he offers a strong resistance, so as to draw him upon a point where troops are posted in force to receive him. To trace anything more than a mere outline, as a guide in operations of this kind, which depend upon so many fortuitous circumstances, would serve but little useful purpose. An active, intelligent officer, with an imagination fertile in the expedients of his profession, will seldom be at a loss as to his best course when the occasion offers; to one without these qualities, opportunities present themselves in vain. See *Ambush* and *Surprise*.

AMBUSH.—Another name for Ambuscade. In former days, when soldiers fought hand to hand more frequently than at present, the ambush was much resorted to; but the tactics of modern times render it less available. It was by an ambush on the part of the revolted Sepoys that so many British soldiers were killed and wounded in that adventure which was known, during the wars of the Indian Mutiny, as the "Disaster at Arrah," in July, 1857. An ambush is neither an "attack" nor a "surprise," in military language; it is something more sudden and unexpected than either. See *Surprise*.

AME.—A French term, similar in its import to the word *chamber*, as applied to cannon, etc.

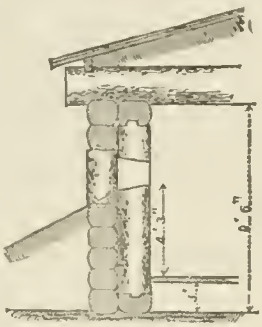
AMENDE HONORABLE.—In the old armies of France, this expression signified an apology for some injury done to another, or satisfaction given for an offence committed against the rules of honor or military etiquette, and was also applied to an infamous kind of punishment inflicted upon traitors, parricides, or sacrilegious persons, in the following manner: The offender being delivered into the hands of the hangman—his shirt stripped off, a rope put about his neck, and a taper in his hand—was led into the Court, where he begged pardon of God, the Court, and his Country. Sometimes the punishment ended there; but often it was only a prelude to death or banishment to the galleys. The *amende honorable* prevails yet in some parts of Europe.

AMENTATÆ.—A sort of lance used by the Romans, which had a leathern strap attached to the center of it.

AMENTUM.—A leathern strap used by the Romans, Greeks, and Galicians to throw lances. It was fastened around the second and third fingers, and a knot was tied on it, which at the throwing of the lance loosened itself.

AMERICAN BLOCK-HOUSE.—In the more recent block-houses erected in the United States for the protection of bridges, railroad-stations, etc., the sides and roof are constructed with a double thickness of logs eighteen inches in diameter, hewn to a face of eight inches where they are in contact. The inner logs are placed upright, the outward horizontal. A space is left in the outward casing sufficient for the fire from the loop-holes made through the inner. The horizontal logs above the loop-holes are held up by short uprights, mortised into them and into those just below. The ceiling is covered with earth, as shown in the section, three feet thick at the ridge and sloping towards the eaves to about six or nine inches, where it is confined by a pole-plate. The earth is protected from the weather by a board roofing. Tin or sheet-iron ventilators are made through the roofing and ceiling, and a brick flue to receive the pipe of the stove used in cold weather. Some of these structures are built in the form of a cross, consisting of a square central chamber, twenty-four feet on a side, and of four wings of the same form and dimensions when the block-house is for cannon. An embrasure is pierced in each of the three sides of each wing to serve a single gun. The cheeks of the embrasures are faced with logs, and the mouth is secured by a musket-proof shutter with a loop-hole in it. The embrasures are below the level of the loop-holes, allowing these to be used whenever necessary. Arrangements for magazines and store-rooms are made under the floor of the block-house in the most secure parts. The entrance to the block-house may be either through a postern, the bottom of which is on the level of that of the ditch, a ramp leading from this level outwards, a door properly secured, and steps, forming the inner communications; or it may be arranged with a plank thrown across the ditch on the same level as the natural ground, the entrance to the door being masked by a double stockade, leaving the same passage-way as that of the doorway. Loop-holes in the door and sides of the building sweep this passage.

The block-house is sometimes arranged with two stories, the corners or the sides of the upper story projecting over the sides of the lower. Either of these methods is sufficient for the defence of the lower story; but the first is the best to procure a fire in the direction of its angles. It can only be used, however, as a defence against infantry. When artillery cannot be brought to bear against the top of the block-house, it may be constructed like an ordinary floor, and be covered with nine or twelve inches of earth to guard against fire. The application of wood to the purposes of defence is one of paramount importance in our country. A block-house, surrounded by a defensive stockade, is impregnable to the attack of infantry if



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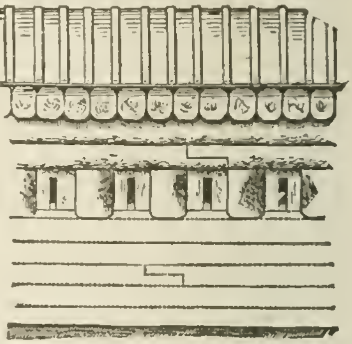


Elevation.

properly defended, and is therefore peculiarly suitable to either wooded or mountainous positions, where a train of artillery cannot be taken without great labor, owing to the impediments that may be thrown in its way, by rendering the roads impassable from obstructions easily obtained. In positions covered by extensive earthen works, such as those that would be required for the defence of the towns on our seaboard, and which would be occupied during a war, a defensive arrangement of the barracks for the troops, so that they might serve, in case of the main works being forced, as rallying-points, under cover of which the main body of troops may retreat with safety, is a subject that commends itself to the serious attention of the engineer. From the details already entered into, an efficient combination for this purpose will suggest itself to the reader, without entering further into particulars. See *Block-house*.

AMERICAN FLAG.—On the 14th of June, 1777, the Continental Congress resolved that the Flag of the United Colonies should show thirteen stripes of red and white alternating, to represent the number of the Colonies, with thirteen stars in a blue field. This became the Flag of the United States, and a star is added for every State added to the Union. The width of the Flag should be two thirds its length. Seven of the stripes, beginning with the outermost, are red. The blue field, or union, is square and has the width of seven stripes. The United States Revenue Flag has sixteen vertical stripes, alternately red and white, with a white union bearing the National Arms in dark blue. See *Flags*.

AMES GUN.—A wrought-iron rifled gun made on the *built-up* principle. Bars of wrought-iron are bent around a mandrel and their ends are welded so as to form rings. After turning them in a lathe, two or more of these rings are fitted one within another to form a disk. These disks are then welded in succession to a concave breech-piece. The shape of the gun is that of the Dahlgren. The trunnions are attached by being screwed into the body of the gun. These guns have shown remarkable endurance. One was fired 1630 times with a 37-pound rifle-shot and $3\frac{1}{2}$ pounds of powder. The chambers have shown some stretching at the welds, and with this a weakness to resist longitudinal strains. The latter is effectually overcome by employing *Dahlgren's breech-strap.* See *Ordnance.*

AMICUS CURIÆ.—Counsel, or at least Amici Curiæ (Friends of the Court), are allowed to prisoners in all cases; but no person is permitted to address the Court, or interfere in any manner with its proceedings, except the parties themselves.

AMMUNITION.—Sometimes this name is given to cannon and mortars, as well as to the projectiles and explosive substances employed with them; but more usually ammunition is considered to apply to the latter—such as shot, shell, gunpowder, cartridges, fuses, wads, grenades. Muskets, swords, bayonets, and other small-arms are sometimes, but improperly, included under this term. The Royal Laboratory at Woolwich is the place where ammunition is chiefly prepared for the British army and navy. The cannon-balls may be cast at some of the great iron foundries in the North; the shells may be cast or forged in the shell-factory at Woolwich; the muskets may be made at Birmingham, and the rifles at Enfield; the bullets at the shot-factories; the gunpowder at Waltham Abbey—and so on; but the "making up" of the ammunition is mostly conducted at the establishment above mentioned. In the United States, ammunition is prepared at the various Arsenals and by numerous private Manufacturing Companies. Bags of serge, in enormous number, are cut out and made, and filled to form the cartridges for large ordnance. Bags or tubes of paper are made and filled to constitute blank cartridges for small-arms; while the ball-cartridges are enclosed in thin copper cylinders. The tubes and combustibles for war-rockets and fuses are also manufactured. The cartridges for small-arms (rifles, muskets, carbines, and pistols) are made in millions; since it is on those that the main offensive operations of an army depend. It has been calculated by the Woolwich Authorities that a British army of 60,000 men, comprising a fair average of infantry, cavalry, artillery, and engineers, ought to be provided with no less than 18,000,000 ball-cartridges for small-arms, for six months' operations. These would require 1000 ammunition-wagons and 3600 horses to convey them all at once. It is therefore deemed better that, under any such circumstances, there should be established *entrepôts* for supplying the troops from time to time. The wagons constructed for this kind of service will carry 20,000 rounds of small-arm ammunition each; the cartridges are packed in boxes, and the wagons are drawn by four horses each. Several wagons are organized into an "equipment," under the charge of a detachment of artillery; and there are several such equipments for an army of the magnitude above mentioned—one for each division of infantry, a small portion for the cavalry, and the rest in reserve. It has been laid down that an army of 60,000 men ought to have 2,680,000 cartridges *with them*, besides those in reserve; and that the conveyance of such a quantity, with a few forges and stores, would require 150 ammunition-wagons, 830 men, and 704 horses. The equipment would return to the *entrepôt* for a new supply when needed. In the Peninsular War, and at Waterloo, the English used two-horse carts, carrying about 10,000 rounds of small-arm ammunition each; but a superior kind of wagon has been since introduced. In the field, an infantry soldier usually carries about 60 rounds, put in compartments in his pouch. When the word ammunition is used in connection with artillery matters, the "fixed" ammunition comprises the loaded shells, cartridges, and carcasses; whereas the "unfixed" are the unfilled case-shot, grape-shot, and shell. During peace, the Woolwich laboratory serves out little less than 1,000,000 lbs. of gunpowder annually, in ammunition for the army and navy, for purposes of exercising, saluting, etc. The chief kinds of ammunition will be found briefly described under their proper headings. See *Ammunition-boxes, Breaking up Ammunition, Cartridge, Center-fire Metallic-case Cartridge, Field and Mountain Ammunition, Fixed Ammunition, Metallic Ammunition for Small-arms, Paper Ammunition for Small-arms, Preservation of Ammunition and Fireworks, Siege and Garrison Ammunition, Stand of Ammunition*, and *Strapped Ammunition.*

AMMUNITION-BOXES.—Packing-boxes for field-ammunition are made of well-seasoned stuff (generally white pine), 1.25 inch thick, dovetailed with the tenon on the ends. The top of the box is fastened with six 2-inch screws; the box has two handles of 1¾-inch rope, attached to brackets at the ends. The boxes are painted on the outside different colors to indicate the contents of the box. Those containing shot are painted *olive;* shells, *black;* spherical case-shot, *red;* and canisters, a *light drab.* The kind of ammunition is marked on each end in large white letters. The place and date of fabrication are marked on the inside of the cover. The boxes are packed as follows:

For Smooth-bore Guns.—*Shot, spherical case* and *canisters, fixed.*—Laid in two tiers across the box, the shot or canisters alternating with the cartridges at each side. The shot or canisters of the upper tier rest on those of the lower and not on the cartridges. Canisters are packed in the same manner, omitting the strips of wood in the bottom of the box.

For 12-pdr. Mountain-howitzer.—*Shells* and *case-shot, fixed.*—Placed upright, the balls down, resting on strips of wood as for the other howitzer. *Canisters* are packed in the same manner, resting on the bottom of the box.

For Rifled Guns.—*Shells* and *case-shot.*—Placed upright, the balls down, resting on strips of wood as for the howitzer. The iron part of the balls rests against strips of wood 4 inches wide and .25 inch thick, nailed to the side and ends of the box at the bottom, and similar strips placed between the rows of the balls to prevent the soft metal cups from bearing against the box or against each other and being bruised; the cartridges are placed on top of the projectiles. *Canisters* are packed in the same manner as the case-shot, omitting the strips of wood on the bottom of the box.

In all the boxes the small stores are placed in the vacant spaces on top of the ammunition. A layer of tow is placed in the bottom of each box, and the whole contents are well packed in tow, filling the box so as to be pressed down by the cover. About three pounds of tow are required for a box. See *Ammunition* and *Madigan Ammunition-box.*

AMMUNITION-CHESTS.—Chests placed on field-limbers and caissons for the transportation and safe-keeping of ammunition. The limber has one and the caisson has three such chests, which will seat twelve cannoneers if necessary. The interior compartments of the ammunition-chests vary according to the nature of the ammunition with which they are loaded.

AMMUNITION-SHOES.—Shoes made for soldiers and sailors in the British service, and particularly for use by those frequenting the magazine, being soft and free from metal.

AMMUNITION-WAGON.—A carriage employed for the transportation of ammunition. The points essential in the general construction of field-artillery carriages apply equally in that of the ammunition-wagon, so far as the traveling conditions are concerned. It need only be observed that the general form of a limber-carriage can be most effectively retained in the ammunition-wagon by substituting a perch for the trail of the gun-carriage, and furnishing it with an eye in front for an attachment to the limber-hook. The arrangement of the ammunition-boxes on the platform of the body must be such as to insure the center of gravity of the entire load falling between the wheels and limber-hook, the pressure on the latter being regulated with particular reference to stability and ease of draught.

AMNESTY.—An act of pardon or oblivion, and the effect of it is that the crimes and offences against the State, specified in the act, are so obliterated that they can never again be charged against the guilty parties. The amnesty may be either absolute or qualified with exceptions. Instances of the latter are to be found in ancient and modern history: thus, Thrasybulus, when he overthrew the oligarchy in Athens, caused an amnesty to be proclaimed, from the operation of which the thirty tyrants, who had formed the oligarchy, and some few persons who had acted under them, were excluded. Again, Bonaparte, on his return from Elba in 1815, issued a decree, which was published at Lyon, declaring an amnesty, from the benefits of which he excepted thirteen persons whom he named. In the absence of specific statutes on the subject, the exercise of amnesty in the United States was assumed to lie with the President. Washington, without participation by Congress, granted amnesty, or pardon, to persons who took part in the "Whisky Rebellion." John Adams proclaimed full pardon of those engaged in the House-tax Insurrection, and Madison did the same in the case of the Barataria Pirates. During the Rebellion, Lincoln and Johnson issued four or five proclamations of amnesty, one of the latest being so broad in its conditions that it raised in Congress the question whether the President had the right to such action, and the Judiciary Committee of the Senate, in February, 1869, decided that he had not. Amnesty is so closely connected with "pardon" and "reprieve" that it is difficult to distinguish them. In one message President Lincoln asserted his exclusive authority under the Constitution, and his independence of Congress in respect to the pardoning power, even more emphatically than in the proclamation. In 1862 Congress had passed an Act giving full power to the President, but he considered the Act unnecessary, claiming that the Constitution gave him the necessary authority. Then, in 1867, the Act of 1862 was repealed; and all amnesty proceedings were remanded to their original basis in the Second Article of the Constitution, until further defined in later amendments. The Supreme Court had decided in the case of Garland that for pardon the President's power was perfect; yet that is not held to include general amnesty. But in 1868 the Fourteenth Amendment to the Constitution, prohibiting rebels from holding certain offices unless their disabilities should first "be removed by a vote of two thirds of each House," seemed to diminish the range of executive authority. Still, the Supreme Court has held in several cases to the absolute power of the President to grant amnesty and pardon, and that neither Congress nor any authority less than an express change of the Federal Constitution can reverse, abridge, or direct that power. The Court, through Chief-Justice Chase, says: "It is the intention of the Constitution that each of the great co-ordinate departments of the government, the legislative, the executive, and the judicial, shall be in its sphere independent of the others. To the executive alone is entrusted the power of pardon, and it is granted without limit. Pardon includes amnesty. It blots out the offense pardoned, and removes all its penal consequences."

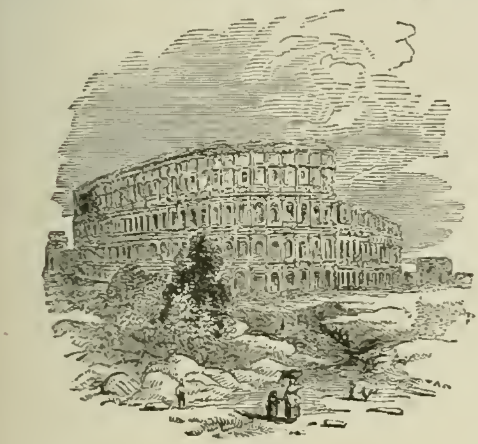
AMORCE.—An old military word for fine-grained powder, such as was sometimes used for the priming of great-guns, mortars, and howitzers; as also for small-arms, on account of its rapid inflammation. The term is also applied to a port-fire or quick-match.

AMORCER.—A French word meaning to decoy, and used in the sense of making a feint in order to deceive the enemy and draw him into a snare.

AMORCOIR.—An instrument used by the French for priming muskets; also a small copper box in which are placed the percussion-caps.

AMPHICTYONIC COUNCIL.—This central politico-religious Court of several Grecian tribes was held twice a year. In spring, the members assembled in the temple of Apollo, at Delphi; in autumn, in the temple of Ceres, at the village of Anthela, near Thermopylæ. Their purpose was twofold: 1. To determine questions of International Law; 2. To preserve the Religious Institutions of the Greeks. As there were many Amphictyonies in the early days of Greek history—of which, however, by far the most important was that which forms the subject of our article—it has generally been supposed that they originated out of a desire for social union, and were, consequently, a result of the national instinct for civilization. Like the Olympic games of a later period, their tendency was to develop a spirit of brotherhood where it was greatly required. The restless Greek intellect, in its application to political life, had naturally an excessive and perilous love of individualism, out of which rose the numerous strifes and animosities of the various States. These Councils, on the other hand, were calculated to exert a wholesome centralizing influence. They knit together, for a time, the distracted tribes in a bond of common interest and piety. Like the Olympic games, too, they became the occasion of vast gatherings of the Greek peoples, who crowded thither for every variety of purpose, sacred and secular; and thus a feeling of unity and pure national patriotism was, temporarily at least, excited in the popular mind. The special origin of the Amphictyonic Council or League is unknown, though we know that it was composed of twelve tribes. The ancient writers differ in the names of these; but the list given by the orator Æschines, though containing only eleven, is perhaps the safest to adhere to: the Thessalians, Bœotians, Dorians, Ionians, Perrhæbians, Magnetes, Locrians, Œtæans, Phthiots, Malians, and Phocians. Probably the remaining tribe was the Dolopians, who are mentioned in other accounts. It has been justly concluded that the great preponderance of the northern tribes, who were of the old Pelasgic race, proves the antiquity of the Council. It must have been older than the descent of the Dorians upon the Peloponnesus, or the emigration of the Ionians to the coasts of Asia Minor. Each of the twelve tribes sent to the Amphictyonic Council two members. These twenty-four Representatives possessed equal authority, although some of the tribes were very small and hardly independent. They bound themselves by an oath that "they would destroy no city of the Amphictyons, nor cut off their streams in war or peace; and if any should do so, they would march against him and destroy his cities; and should any pillage the property of the god, or be privy to, or plan anything against, what was in his temple at Delphi, they would take vengeance on him with hand, and foot, and voice, and all their might." It is only right to state, what indeed most people would naturally conclude for themselves, that so excellent an oath was very indifferently kept. In the primitive period of Greek history, it, in all likelihood, exerted the beneficial and civilizing influence of which we have spoken; but it opposed only a feeble check to the passions and ambition of a more powerful age. The members at times connived and even took part in many political crimes, and thus violated their oath.

AMPHITHEATER.—A spacious building, generally elliptical in form, used by the Romans for exhibiting gladiatorial combats, fights of wild beasts, and other spectacles. The Amphitheater differed from a theater for dramatic performances in this, that whereas the theater had only a semicircle of seats fronting the stage, the Amphitheater was entirely surrounded by them; and hence the name of Amphitheater. Till a late period at Rome, these erections were of wood, and merely temporary, like a modern race-stand. They seem, however, to have been of enormous size, as Tacitus mentions one, during the reign of Tiberius, which gave way and caused the death or injury of 50,000 spectators. Amphitheaters of stone had begun, however, to be erected at an earlier period than this, the first having been built at the desire of Augustus. The Flavian Amphitheater at Rome, known as the Colosseum, which was begun by Vespasian, and finished by Titus 80 A.D., ten years after the destruction of Jerusalem, was probably the largest structure of the kind, and is fortunately also the best preserved. It covers about five acres of ground, and was capable of containing 87,000 persons. Its greatest length is 620 feet, and its greatest breadth 513. On the occasion of its dedication by Titus, 5000 wild beasts were slain in the arena, the games having lasted for nearly 100 days. The exterior is about 160 feet in height, and consists of three rows of columns, Doric, Ionic, and Corinthian, and above all a row of Corinthian pilasters. Between the columns there are arches, which form open galleries throughout the whole building; and between each alternate pilaster of the upper tier there is a window. There were four tiers or stories of seats, corresponding to the four external stories. The first of these is supposed to have contained twenty-four rows of seats, and the second sixteen. These are separated by a lofty wall from the third story, which is supposed to have contained the populace. The *podium* was a kind of



Colosseum.

covered gallery surrounding the arena, in which the Emperor, the Senators, and Vestal Virgins had their seats. The building was covered by a temporary awning or wooden roof, called *velarium*, the mode of adjusting and fastening which has given rise to many antiquarian conjectures. The open space in the centre of the Amphitheater was called *arena*, the Latin word for sand, because it was covered with sand or saw-dust during the performances. The taste for the excitement of the Amphitheater which existed at Rome naturally spread to the provinces, and large amphitheaters were erected not only in the provincial towns of Italy, as at Capua, Verona, Pompeii, etc., but at Arles and Nismes, in France; and even in England, at Cirencester, Silchester, and Dorchester.

AMPLITUDE.—In gunnery, the range of a shot, or the horizontal right line, which measures the distance over which it has passed.

AMPOULETTE.—A wooden cylinder which contains the fuse of a hollow projectile.

AMPUTATION.—A surgical process of frequent necessity on the field of battle. The amputation of a limb was in ancient times attended with great danger of the patient's dying during its performance, as Surgeons had no efficient means of restraining the bleeding. They rarely ventured to remove a large portion of a limb, and when they did so they cut in the gangrened parts, where they knew the vessels would not bleed ; the smaller limbs they chopped off with a mallet and chisel; and in both cases had hot irons at hand with which to sear the raw surfaces, boiling oil in which to dip the stump, and various resins, mosses, and fungi, supposed to possess the power of arresting hemorrhage. Some tightly bandaged the limbs they wished to remove, so that they mortified and dropped off; and others amputated with red-hot knives, or knives made of wood or horn dipped in vitriol. The desired power of controling the hemorrhage was obtained by the invention of the tourniquet in 1674 by a French Surgeon, Morell. The ancient Surgeons endeavored to save a covering of skin for the stump by having the skin drawn upwards by an assistant, previously to using the knife. In 1679 Lowdham of Exeter suggested cutting semicircular flaps on one or both sides of a limb, so as to preserve a fleshy cushion to cover the end of the bone. Both these methods are now in use, and are known as the "circular" and the "flap" operations: the latter is more frequently used in this country. A flap amputation is performed thus: The patient being placed in the most convenient position, an assistant compresses the main artery of the limb with his thumb, or a tourniquet is adjusted over it. Another assistant supports the limb. The Surgeon with one hand lifts the tissues from the bone, and, transfixing them with a long narrow knife, cuts rapidly downwards and towards the surface of the skin, forming a flap; he then repeats this on the other side of the limb. An assistant now draws up these flaps, and the knife is carried round the bone, dividing any flesh still adhering to it. The Surgeon now saws the bone. He then, with a small forceps, seizes the end of the main artery, and drawing it slightly from the tissues, an assistant ties it with a thread. All the vessels being secured, the flaps are stitched together with a needle and thread, and a piece of wet lint is laid over the wound. An expert Surgeon can remove a limb thus in from thirty to sixty seconds.

AMUSETTE.—A stocked gun mounted on a swivel, and carrying a ball or charge of buck-shot of from 8 to 32 ounces' weight. The *amusette* invented by the celebrated Marshal Saxe carried a half-pound leaden ball.

ANABASH.—Expeditious couriers, in antiquity, who carried dispatches of great importance in the Roman Wars.

ANACARA.—A sort of drum much used by the Oriental cavalry and mounted troops.

ANACLETICUM.—A particular blast of the trumpet, in the ancient art of war, whereby the fearful and flying soldiers were rallied to the combat.

ANALYSIS OF POWDER.—In the inspection of gunpowder, the following is the usual process of analyzing: Pulverize 75 grains, place in a glass beaker with eight ounces of distilled water; stir rapidly with a glass rod; when clear, test with litmus-paper for acids and with turmeric for alkalies. Wash repeatedly to remove all the sulphur and charcoal, and examine the residuum with a microscope for coarse particles of either or foreign substances. Determine the amount of moisture by placing 45 grains of powder, ground fine, in a watch-crystal, dry thoroughly, and cover the crystal with another. The weight of dish and cover being known, the loss of weight due to moisture contained in them is found.

Put the 45 grains of dry powder in a pipette, having a wad of heated asbestos in the narrow part; verify the weight of the pipette and wad; insert the pipette into a hole in the cork of a small weighed flask; treat the powder with 50 c.c. of rectified bisulphide of carbon, remove the pipette and cork, recork the flask, and distil off the bisulphide of carbon for future use. A sand-bath is used during distillation, which must proceed very slowly, the flask being raised above the sand, which must not become too warm. The percentage of sulphur is calculated from the weight thus obtained. One tenth per cent is added to the amount of sulphur, as that quantity generally remains in the powder after the treatment with the bisulphide of carbon.

The pipette containing the residue is fixed in a small weighed flask, the portion above the crook being wrapped in muslin. The tube of the flask is connected with an air-pump by a rubber tube, and the contents of the pipette treated with 40 c.c. of distilled water; work the pump carefully to allow the water to enter the flask by drops; to prevent crystallization of the dissolved niter in the narrow part of the pipette, cold water is first used, then warm, and lastly hot. Drench the muslin on the pipette with water of the same temperature as that for dissolving the niter. When the flask contains 40 c.c. of the niter solution, remove the pipette and evaporate the water on a sand-bath, removing the flask occasionally, and cool as the solution becomes saturated. When the niter is crystallized, it is heated until it and the flask are quite dry; the weight of the niter is then taken.

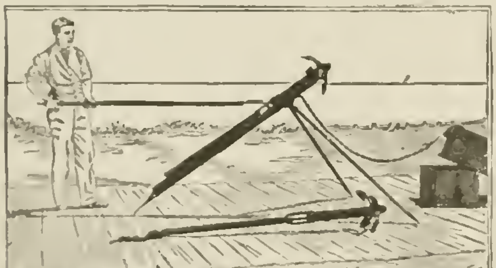
The asbestos wad and a large part of the charcoal are pushed out of the pipette by a wire into a watch-glass; the pipette and watch-glass and contents dried and weighed; the weight of the pipette, watch-glass, and asbestos being known, that of the charcoal is obtained. The weight added to the sulphur is of course deducted. See *Gunpowder* and *Inspection of Powder*.

ANARCHY.—The state of society without any regular government, when a country is torn by the strife of parties, and no law or authority remains. Complete anarchy is necessarily rare and of short duration; but conditions approaching to it often arise after revolutions and gross abuses in government; and in such cases it is apt to become, as in the South American States, a chronic or permanent evil, attended with constant national decay.

ANCHOR.—An iron instrument composed of a long shank, having a ring at one end to which the cable is fastened, and at the other branching out into two arms or flukes tending upwards with hooks or edges on each side; its use in an army equipment is to moor transports, boats, pontoons, and rafts. It is also a good hold for a capstan. The weights of anchors vary according to the particular use they are put to.

ANCHOR-BALL.—A contrivance for saving life in cases of shipwreck. It consists of a ball having several hinged prongs fitting in slots, which are intended to catch in the rigging of a stranded vessel. The ball is fired from a mortar, and carries a light line by which a stout rope may be carried ashore from the vessel. The French use a ball for this purpose having a harpoon passing through it, on the rear end of which a line is wound. The term *anchor-ball* is also applied to a carcass or incendiary ball affixed to a grapnel by which it is intended to adhere to and fire a vessel.

ANCHOR-ROCKET.—An 8-centimeter rocket (8^{cm} Ankerrakete), used by the Germans for life-saving purposes, composed of a body, anchor-head, base, rocket-stick, and chain. The case, or rocket-body, is made of sheet-metal, .06 inch in thickness. The anchor-head is made of iron. The front end is sub-spherical in form, connected with the convex curves of the arms



by re-entrant tangent-curved surfaces. The short shank in rear of the head forms a cylindrical tenon that fits the front end of the rocket-case, to which it is secured by screws. The arms and flukes are four in number. The former are triangular-prismoidal in outline, and are placed at right angles to each other. The arms are furnished with the usual palmate flukes, which are well adapted for "holding." The rear end of the rocket-case is reinforced on the inside for 1.5 inch of its length by a cylindrical iron ring. The latter furnishes a seat into which the screws that attach the base are turned. The base is tripodal in form, the legs joining a cylindrical ring at the front end. The conjunction of the legs, or ribs, at the rear end forms a seat into which is screwed the rocket-stick.

When prepared for use and ready for packing the rocket-case is filled with composition and the rear end of the case closed with a water-proof cap to protect the contents from the effects of moisture. This cap is placed 1.3 inch towards the front from the rear edge of the basal ring. A fuse, 2.7 inches in length and .5 inch in diameter, passes through the cap and connects with the rocket composition. The projecting fuse is liable to be broken off in handling if great care is not exercised, as the operator will involuntarily thrust his hand between the ribs to grasp the rocket in picking it up or carrying it. The fuse is steadied in its position by a strap of laboratory paper attached to one of the ribs in the same manner as in the 5^{cm} rocket. The fuse is coated with shell-lac varnish.

The rocket-*stick*, technically so called, is a hollow cylindrical tube of sheet-metal, with a diameter about equal to that of the wooden stick for the 8^{cm} life-saving rocket. It is constructed by taking a strip of sheet-metal of the necessary length and width, curving it and fastening the edges together with twenty-three iron rivets. The front end is filled with an iron plug extended to the front as a frustum of a cone, 1.125 inch in altitude, from which projects the male screw, 2.25 inches long, that enters the base of the rocket when assembled for use. The rear end is furnished with an iron loop having flattened arms that are riveted to the tube. This loop serves as the point of attachment for the rocket-chain. The rocket-chain is made of the best wrought-iron. The rocket-case, base, and "stick" form the *shank* of the quadripalmate anchor. The usual anchor *stock* is absent in this combination. The anchor-rocket, rocket-stick, and chain are all painted black.

The following are the principal dimensions and weights:

	Inches.	Centimeters.
Total length of 8^{cm} anchor-rocket	33.15	84.19
Rocket case:		
Length	20.15	51.17
Exterior diameter	3.22	8.17
Interior diameter	3.1	7.87
Anchor-head:		
Total length	6.5	16.51
Diameter, excluding arms	3.35	8.50
Length of tenon-shank	1.85	4.69
Diameter of tenon-shank	3.1	7.87
Arms:		
Depth near shank	1.4	3.55
Width under side near shank	1.2	3.04
Depth near fluke	0.8	2.03
Width under side near fluke	0.8	2.03
Spread of flukes	15.5	39.36
Length of palms	3.75	9.51
Width of palms	3.75	9.51
Base-ring:		
Length	1.5	3.81
Exterior diameter	3.1	7.87
Interior diameter	2.87	7.28
Base:		
Total length	9.4	23.87
Diameter, front end	3.75	9.51
Diameter, rear end	1.8	4.57
Length of, embracing case	1.4	3.55
Depth of ribs, front end	0.75	1.90
Depth of ribs, rear end	0.80	2.03
Width of ribs	0.40	1.01
Rocket-stick:		
Total length	39.375	99.98
Length of screw	2.25	5.71
Diameter of screw	0.875	2.21
Rocket-chain:		
Total length	123.0	312.41
Ring:		
Exterior diameter	1.5	3.81
Interior diameter	0.7	1.77
Links:		
Length	1.5	3.81
Width	0.75	1.90
Thickness	0.20	0.50
Total length of rocket and stick	70.275	178.47
	Lbs	Kilos.
Average weight of anchor-rocket	37.375	16 95
Average weight of rocket-stick and chain	9.0	4.08

The German Anchor and Life-saving Rockets are packed securely in tin-lined boxes. The boxes are made of hard pine, planed smooth on both sides, with the corners dovetailed. The bottom, sides, and ends are lined with tin. The top is not lined and is screwed to the sides and ends. A label on the inside of the cover of the box bears printed on its face a list of the contents of the box in the German language. A similar label is pasted on the end of the box. The rocket-boxes are oiled but not painted. Bottom, middle, and top clamps at each end hold the rockets in place. A strip of felt separates the rockets from the clamps. See *Chandler Anchor-shot*, *German Life-saving Rocket*, *Life-saving Rockets*, *Lyle-Emery Grapple-shot*, and *Rockets*.

ANCIENT.—A term formerly used to express the grand ensign or standard of an army.

ANCIENT AND HONORABLE ARTILLERY COMPANY.—The first regularly organized military company in America, formed in 1637, and copied from the Honorable Artillery Company of London, dating from 1537. The Boston Company was chartered June, 1638, has always been vigorously sustained, and is noted for the eminent citizens in its membership. It has an annual parade, sermon, and dinner, formal and dignified. A third and elaborately illustrated history of the Company has been recently published. See *Artillery Corps* and *Honorable Artillery Company*.

ANCILE.—A kind of shield, in antiquity, which fell, as pretended, from heaven, in the reign of Numa Pompilius; at which time, likewise, a voice was heard declaring that Rome would be mistress of the world as long as she should preserve this holy buckler.

ANCONY.—A foundry term for a piece of partially wrought bar-iron, partly finished in the middle, but unwrought at the ends.

ANDABATÆ.—In military antiquity a kind of gladiators who fought hoodwinked, wearing a style of helmet that covered the eyes and face. They fought mounted on horseback, or on chariots.

ANDREW.—The Order of St. Andrew, or The Thistle, is a Scottish order of knighthood, named after the Patron Saint of Scotland. Nisbet, with pardonable partiality, prefers it to all other orders, purely military, "chiefly for the antiquity of it, which gives it a place and precedency over all other orders now in being." He then proceeds, after Bishop Lesley, to recount the story of the St. Andrew's cross having appeared in heaven to Achaius, king of Scots, and Hungus, king of the Picts, as a sign of the victory which they should gain the following day over Athelstane, king of England; and their subsequent vow, when the prophecy was fulfilled, to bear it on their ensigns and banners. It is frequently said to have been recognized as an order of knighthood in the reign of James V., and, after a period of abeyance, to have been revived by James II. of Great Britain in 1687. For the actual facts of the case see, however, the article *Thistle*. The Star of the Order of the Thistle is worn on the left side. It consists of a St. Andrew's Cross of silver embroidery, with rays emanating from between the points of the cross, in the center of which is a thistle of gold and green upon a field of green, surrounded by a circle of green, bearing the motto of the order in golden characters. The badge or jewel is worn pendent to the collar, or to a dark-green ribbon over the left shoulder, and tied under the arm. It consists of a figure of St. Andrew with the cross enamelled and chased on rays of gold; the cross and feet resting upon the ground of enamelled green. The collar is of thistles, intermingled with sprigs of rue. By a statute passed in May, 1827, the order is to consist of the Sovereign and sixteen Knights. The letters K. T. are placed after the names of knights of the order. The motto is *Nemo me impune lacesset*. Nisbet, differing from Sir George Mackenzie, prefers *lacesset*, as "having more of daring and gallantry." See *Thistle*.

Star of the Order of the Thistle.

ANELACE.—A short sword of the fifteenth century, so called because it was worn fastened to a ring. It had a blade very broad at the top, but gradually tapering towards the end till it came into a point like a tongue, which form seems to have been copied from the ancient *parazonium*.

ANEMOGRAPH.—An instrument used in target-practice for measuring and recording the direction and force of the wind. See *Anemometer*.

ANEMOMETER.—An instrument for measuring the strength and velocity of the wind. A simple anemometer and one much used in ballistics is the Robinson hemispherical-cup instrument, shown in Fig. 1. It consists of four hollow hemispheres or cups fixed to the ends of two horizontal iron rods crossing each other at right angles, and supported on a vertical axis which turns freely. The cups revolve with a third of the wind's velocity, and the instrument is so constructed that five hundred revolutions are made whilst a mile of wind passes over it. The revolutions are registered by a system of wheels similar to those of an ordinary gas-meter. The difference between two readings gives the number of revolutions passed over during the intervening time, from which the miles can be calculated, and the rate per hour.

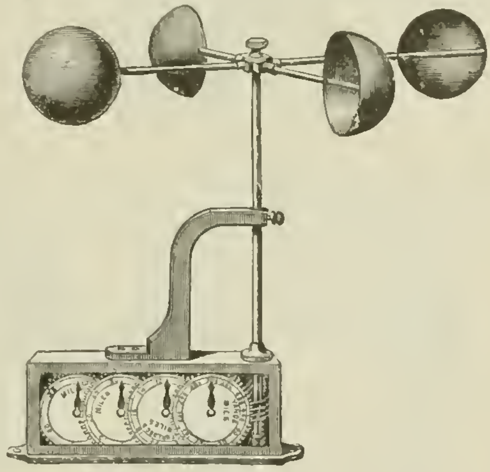


Fig. 1.

Dr. Robinson entertained the theory that the cups (measuring from their center) revolved with one third of the wind's velocity, and this theory having been supported by experiment, allowance has been made in graduating the wheels so that the true velocity is obtained by direct observation.

The first dial indicates hundreds of thousands of revolutions or miles, according to mode of division; the second, tens of thousands; the third, thousands; the fourth, hundreds; and the fifth, tens. Should the index point *between* two figures, the lesser of the two is to be taken. Whenever the index of the first dial is found to have passed zero (0), a cross or star is to be prefixed to the next reading. The number of *thousands* of revolutions made during a month is ascertained by subtracting the first reading from the last, and prefixing to the figures thus obtained a figure corresponding to the number of stars in the column. Every thousand revolutions represent two miles of wind, and the number of miles which have passed in a month is ascertained, therefore, by multiplying by 2.

To ascertain the velocity of the wind for a short period: Take two readings of all the dials with an interval of twelve minutes. The difference of these readings, divided by ten, is the velocity of the wind in miles per hour. Pressure-anemometers are of very

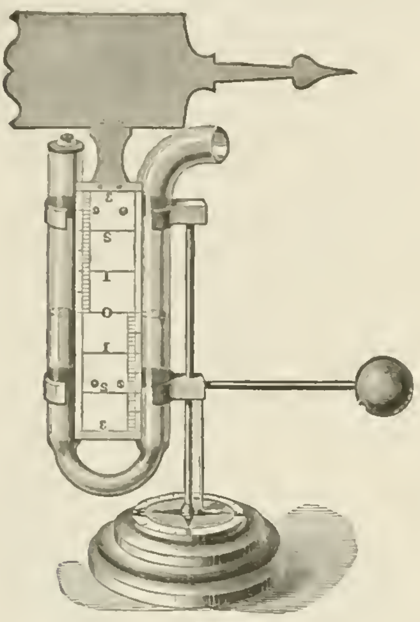


FIG. 2.

great importance in meteorological observatories. Of these, the most complete is that invented by Osler. In this instrument, the force of the wind is ascertained in a different way from the hemispherical-cup anemo-

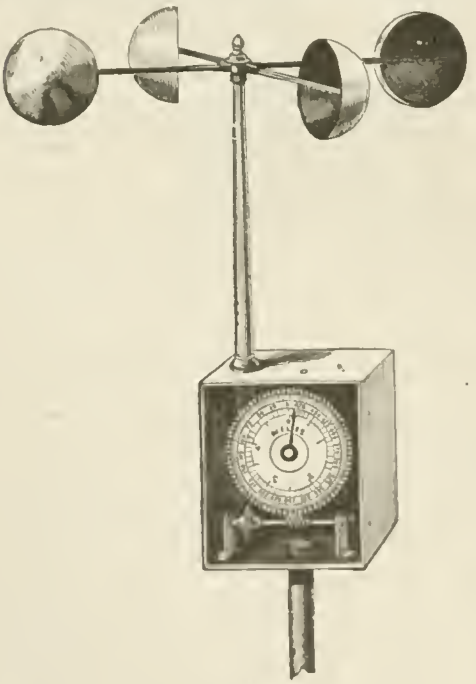


FIG. 3.

meter. A brass plate one foot square is suspended by means of springs, and being attached to the vane of the instrument, is maintained at right angles to the direction of the wind. This plate, by the action of the wind, is beaten back upon the springs, and in so doing causes a pencil to move backwards and forwards on a sheet of paper placed below it. This sheet of paper is made to pass under the pencil in a direction at right angles to its oscillation, and by means of clock-work moves at a uniform rate, so that the force of the wind at any particular time of the day is recorded with perfect accuracy. A pencil in connection with the vane, and moving in the same transverse line as the former, records the changes in the direction of the wind; and a third pencil, guided by a rain-gauge, registers the quantity of rain that has fallen. The Lind anemometer, shown in Fig. 2, is very convenient for rough purposes. It consists of a glass siphon, with parallel limbs, mounted upon a vertical rod, on which it moves freely by the action of the vane which surmounts it. The upper part of one of the limbs is bent outward to the wind. Between the limbs is a scale, graduated from 0 to 3 in tenths, the zero being in the center of the scale. In use, the tube is filled with water to the zero of the scale, and exposed to the action of the wind, by which the water is depressed in the one limb and raised in the other. The sum of the elevation and depression is the height of the column which the wind is capable of sustaining. The Beckley anemometer, shown in Fig. 3, is a modification of that of Robinson. The hemispherical cups act by a vertical axis upon two graduated concentric circles, the inner one representing five miles, divided into tenths, and the outer one having one hundred divisions, each of which is equivalent to five miles. At the top of the dial is a fixed index, which, as the toothed wheel revolves, marks on the inner circle the miles (up to five) and the hundredths of miles the wind has traveled, while a movable index, which revolves with the wheel, indicates on the outer circle the passage of every five miles. If, when placing the instrument, the hands stand at 0, the next reading will show the number of miles the wind has traveled; but should they stand otherwise the reading may be noted and deducted from the second reading, thus: Suppose the fixed index points to 2.5 and the movable index to 125, the reading after twelve hours may be 200 on the outer circle and 3.0 on the inner circle; these added together give 203. By deducting the previous reading, 127.5, we have the true reading, viz., 75.5 miles as the distance traveled by the wind.

ANEMOSCOPE.—An instrument for showing the course or direction of the wind. It is related that Andronicus Cyrrhestes built an octagonal tower at Athens, having at each side a statue of the god to whom the wind blowing from that quarter was dedicated; and in the middle of the tower was a small spire having a copper Triton, which, being put in motion by the wind, pointed to the deity from whom it proceeded. The custom of putting vanes on church-steeples is at least as old as the middle of the ninth century; and as these vanes were frequently made to resemble a cock, the emblem of clerical vigilance, they received the name of weather-cocks. The anemoscope may be combined with the anemometer, thus indicating both the direction and the force of the wind. Latterly the anemoscope has been made self-recording, and now in most observatories needs no watching, every movement of the wind being written down; the force or pressure and the velocity in miles per hour being also recorded. This is done by pencils which press lightly upon a cylinder covered with a sheet of paper divided into horizontal hour-lines, the lines moving at the rate of half an inch an hour, a complete revolution of the cylinder occupying twenty-four hours. Lines marked by the pencils show by their relation to the graduated lines the direction of the wind at any moment of the day.

ANEROID BAROMETER.—An instrument for indicating atmospheric pressure. Invented about the beginning of the present century, it was not until about 1848 that the difficulties involved in the construction of such an instrument were overcome, and the present serviceable form devised by M. Vidie. Since that time the aneroid has continued substantially the same; improvements being rather in the direction of more perfect workmanship in its parts, and in the more perfect adaptation of its metals, than in any change of form.

As shown in Fig. 1, the aneroid consists of a flat cylindrical vacuum-box, the upper surface of which is corrugated in order that it may yield more readily to external pressure. The lower surface of the vacuum-chamber is firmly fixed at the center to a strong foundation-plate, whilst at the center of the upper surface is a metallic pillar, M, which acts upon a powerful steel spring, R. The varying atmospheric pressure causes the surface of the vacuum-chamber to rise and fall; these movements are transmitted to the spring, and thence by two levers, *l* and *m*, to a metallic axis, *r*. From the latter rises a lever, *t*, to whose extremity a chain, *s*, is attached, which turns a drum the axis of which bears the index-needle. A firm spiral spring keeps the chain constantly in proper tension. By this arrangement of multiplying levers, a very small movement of the surface of the vacuum-chamber causes a large deviation of the needle; $\frac{1}{200}$ of an inch causing it to move through a space of three inches. Compensation for temperature is effected, as in chronometers, by an adjustment of brass and steel in the main lever, by whose unequal expansion and contraction the liability to error from change of temperature is overcome. The dial is graduated arbitrarily to correspond with the mercurial barometer, after the instrument is tested under the air-pump to find the range. It is apparent, therefore, that the aneroid can never be used as an independent standard, but must be frequently compared with the mercurial barometer. When so compared, however, and adjusted by a mercurial standard, the aneroid possesses several advantages over the former. It is extremely portable and can be carried in any way, or subjected to any motion without danger of disturbance of its indications. It is not at all liable to get out of order; is not easily broken; and lastly, *it is very much more sensitive* than the mercurial barometer. The late Admiral Fitzroy, Mr. Glaisher the aeronaut, and many other authorities, testify to the extreme sensibility of the aneroid; the former particularly noting "its quickness in showing the variations of atmospheric pressure." Even in observatories, therefore, where mercurial standards are in use, the aneroid is most valuable in its capacity of giving earlier indications than can be obtained from the more sluggish mercurial column. To the seaman, who has often extreme difficulty in using the barometer from the pumping of the mercury caused by the vessel's motion, the aneroid is indispensable; and from its greater delicacy, he can often prepare for a change in weather a considerable time before the mercurial barometer gives evidence of an impending storm.

Fig. 2 represents the mining and surveying aneroid, designed for the purpose of readily ascertaining slight variations in gradients, levels, etc. Besides extreme sensitiveness, the specialty claimed for this instrument is an arrangement of the scale of altitudes which admits of subdivision by a vernier, hitherto impracticable, owing to the altitude scale in ordinary use being a gradually diminishing one, to which a vernier cannot be applied. In the present instrument the action has been so adjusted as to give accurate readings upon a regular scale of altitudes, the barometrical scale of inches having been made progressive so as to afford the correct relative readings with the scale of altitudes. For mining purposes the entire circle of the dial is graduated to represent 6 inches of the mercurial column, i.e., from 27 inches to 33. This scale will register about 2000 feet *below* sea-level to 4000 feet *above;* the finest divisions, hundredths of the altitude scale, represent 10-feet measurements, which can be again subdivided by the vernier scale to *single feet.* The vernier scale is moved by a rack-work adjustment, and a magnifying-lens which rotates on the outer circumference of the instrument facilitates the reading of minute quantities. For surface-surveying purposes, where it is not required to be used *below* sea-level, the instrument is made with the scale divided from 25 to 31 inches, thus giving an altitude scale of 5000 feet above sea-level only, and with this open scale and the assistance of the vernier the same minute readings can be easily taken.

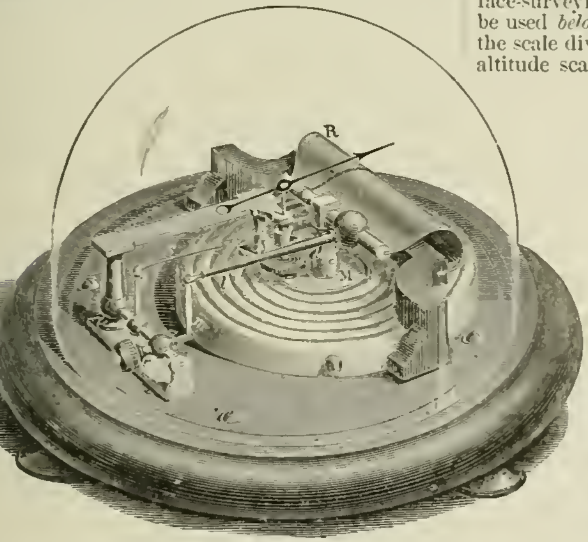


Fig. 1.

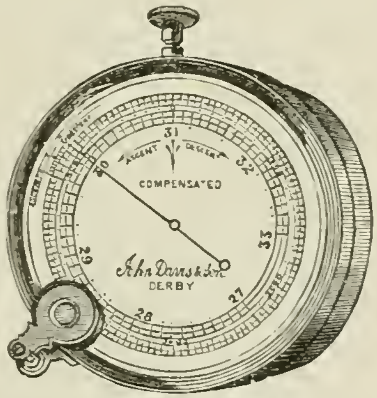


Fig. 2.

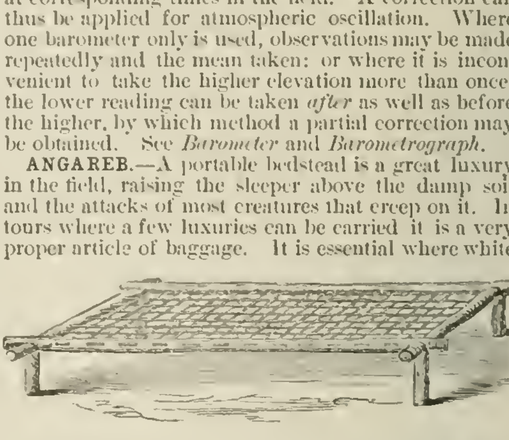
From its portability, sensitiveness, and the ease with which approximate altitudes may be ascertained, the aneroid barometer is very valuable to the engineer. In preliminary surveys and reconnoissances it has been found extremely useful, and for these purposes it is largely employed. Carrying one of these little instruments, the size of which need not exceed two or three inches in diameter, the engineer, riding rapidly over a country, can speedily and with ease procure the data for the determination of the line of a survey. Holding an aneroid in his hand, the traveler seated in the railroad-car can mark the changes of elevation as his train moves; the mountain-climber can note, step by step, his gain in altitude; and the miner, with the new mining aneroid, can measure his descent in single feet. For hypsometrical work it is especially important that the aneroid should be absolutely accurate; that its compensation for effect of temperature on the metallic works be perfect, and that its indications should be identical with those of the mercurial column. The importance of compensation, particularly for pocket-aneroids, is evident when it is remembered that the change from a room to the external atmosphere may frequently involve a difference in temperature of from 30° to 50° F., a difference which, without proper compensation, may move the needle through a space equal to one hundred or more feet. It is also necessary that the aneroid be tested for correspondence with the mercurial column. For this purpose there is an apparatus specially arranged, by which the aneroid and a standard mercurial barometer are subjected to identical changes of atmospheric pressure. Side by side the two barometers are moved through the entire range from normal pressure to complete vacuum. If the scale of the aneroid be accurately divided and in accord with the instrument itself, the needle will move tenth by tenth with the mercurial column, in perfect coincidence. The best results, in all problems of altitude, with the aneroid barometer are obtained by the use of the following table prepared by Sir G. Airy, late Astronomer Royal of England. To use this table (arranged for temperature of 50° F.), take the reading in inches of the barometer scale at the lower and upper stations. Find in the table the heights in feet corresponding to the barometer readings; subtract them, and the remainder will be the height required. When the mean temperature is above or below 50° F., the following correction must be applied: add together the temperature of the upper and lower stations. If the sum is greater than 100° F., *increase* the height by $\frac{1}{1000}$ part for every degree of the excess above 100°; if the sum is less than 100°, *diminish* the height by $\frac{1}{1000}$ part for every degree less than 100°. The complete formula is

$$D = (H - h)\left(\frac{1 + T + t - 100}{1000}\right).$$

T and t are the observed temperatures; H and h are the heights in feet taken from the table.

of time elapses between two observations, engineers are now accustomed to use two matched barometers, one of which is kept in camp, where observations are taken at stated intervals, whilst the other is observed at corresponding times in the field. A correction can thus be applied for atmospheric oscillation. Where one barometer only is used, observations may be made repeatedly and the mean taken: or where it is inconvenient to take the higher elevation more than once, the lower reading can be taken *after* as well as before the higher, by which method a partial correction may be obtained. See *Barometer* and *Barometrograph*.

ANGAREB.—A portable bedstead is a great luxury in the field, raising the sleeper above the damp soil and the attacks of most creatures that creep on it. In tours where a few luxuries can be carried it is a very proper article of baggage. It is essential where white



ants are numerous. A very comfortable bed, shown in the drawing, is made on the principle of a tennis-player's racquet; being a framework of wood, with strips of raw-hide lashed across it from side to side and from end to end. It is the *Angareb* of Upper Egypt, and may be readily constructed in the field. See *Camp-bedstead*.

ANGARIA.—According to ancient military writers, a guard of soldiers posted in any place for the security of it. Angaria, in civil law, implies a service by compulsion; as, furnishing horses and wagons for conveying corn and other stores for the army.

H'ght in Feet.	Aneroid, or Corrected Barometer.	H'ght in Feet.	Aneroid, or Corrected Barometer.	H'ght in Feet.	Aneroid, or Corrected Barometer.	H'ght in Feet.	Aneroid, or Corrected Barometer.	H'ght in Feet.	Aneroid, or Corrected Barometer.	H'ght in Feet.	Aneroid, or Corrected Barometer.	H'ght in Feet.	Aneroid, or Corrected Barometer.	H'ght in Feet.	Aneroid, or Corrected Barometer.
ft.	in.	ft	in.	ft.	in.	ft.	in.	ft.	in.	ft.	in.	ft.	in.	ft.	in.
0	31.000	1500	29.340	3000	27.769	4500	26.282	6000	24.875	7500	23.543	9000	22.282	10500	21.089
50	30.943	1550	29.286	3050	27.718	4550	26.234	6050	24.829	7550	23.500	9050	22.241	10550	21.050
100	30.886	1600	29.233	3100	27.667	4600	26.186	6100	24.784	7600	23.457	9100	22.200	10600	21.012
150	30.830	1650	29.179	3150	27.616	4650	26.138	6150	24.738	7650	23.414	9150	22.160	10650	20.973
200	30.773	1700	29.126	3200	27.566	4700	26.090	6200	24.693	7700	23.371	9200	22.119	10700	20.935
250	30.717	1750	29.072	3250	27.515	4750	26.042	6250	24.648	7750	23.328	9250	22.079	10750	20.896
300	30.661	1800	29.019	3300	27.465	4800	25.994	6300	24.602	7800	23.285	9300	22.038	10800	20.858
350	30.604	1850	28.966	3350	27.415	4850	25.947	6350	24.557	7850	23.242	9350	21.998	10850	20.820
400	30.548	1900	28.913	3400	27.364	4900	25.899	6400	24.512	7900	23.200	9400	21.957	10900	20.782
450	30.492	1950	28.860	3450	27.314	4950	25.852	6450	24.467	7950	23.157	9450	21.917	10950	20.744
500	30.436	2000	28.807	3500	27.264	5000	25.804	6500	24.423	8000	23.115	9500	21.877	11000	20.706
550	30.381	2050	28.754	3550	27.214	5050	25.757	6550	24.378	8050	23.072	9550	21.837	11050	20.668
600	30.325	2100	28.701	3600	27.164	5100	25.710	6600	24.333	8100	23.030	9600	21.797	11100	20.630
650	30.269	2150	28.649	3650	27.115	5150	25.663	6650	24.288	8150	22.988	9650	21.757	11150	20.592
700	30.214	2200	28.596	3700	27.065	5200	25.616	6700	24.244	8200	22.946	9700	21.717	11200	20.554
750	30.159	2250	28.544	3750	27.015	5250	25.569	6750	24.200	8250	22.904	9750	21.677	11250	20.517
800	30.103	2300	28.491	3800	26.966	5300	25.522	6800	24.155	8300	22.862	9800	21.638	11300	20.479
850	30.048	2350	28.439	3850	26.916	5350	25.475	6850	24.111	8350	22.820	9850	21.598	11350	20.441
900	29.993	2400	28.387	3900	26.867	5400	25.428	6900	24.067	8400	22.778	9900	21.558	11400	20.404
950	29.938	2450	28.335	3950	26.818	5450	25.382	6950	24.023	8450	22.736	9950	21.519	11450	20.367
1000	29.883	2500	28.283	4000	26.769	5500	25.335	7000	23.979	8500	22.695	10000	21.479	11500	20.329
1050	29.828	2550	28.231	4050	26.720	5550	25.289	7050	23.935	8550	22.653	10050	21.440	11550	20.292
1100	29.774	2600	28.180	4100	26.671	5600	25.242	7100	23.891	8600	22.611	10100	21.401	11600	20.255
1150	29.719	2650	28.128	4150	26.622	5650	25.196	7150	23.847	8650	22.570	10150	21.361	11650	20.218
1200	29.665	2700	28.076	4200	26.573	5700	25.150	7200	23.803	8700	22.529	10200	21.322	11700	20.181
1250	29.610	2750	28.025	4250	26.524	5750	25.104	7250	23.760	8750	22.487	10250	21.283	11750	20.144
1300	29.556	2800	27.973	4300	26.476	5800	25.058	7300	23.716	8800	22.446	10300	21.244	11800	20.107
1350	29.502	2850	27.922	4350	26.427	5850	25.012	7350	23.673	8850	22.405	10350	21.205	11850	20.070
1400	29.448	2900	27.871	4400	26.379	5900	24.966	7400	23.629	8900	22.364	10400	21.166	11900	20.033
1450	29.394	2950	27.820	4450	26.330	5950	24.920	7450	23.586	8950	22.323	10450	21.128	11950	19.996
1500	29.340	3000	27.769	4500	26.282	6000	24.875	7500	23.543	9000	22.282	10500	21.089	12000	19.959

It should be borne in mind that all aneroids vary in their readings with the position in which they are held, reading somewhat higher in a horizontal position with face up than when vertical. As they are tested and adjusted in a horizontal position, it is better that they should be uniformly read from the horizontal dial. Before a reading is taken, the face should be tapped slightly with the finger to bring the needle fairly into equilibrium. As there may be considerable atmospheric variation if any great interval

ANGELIAPHORI.—An ancient name for the reconnoitring parties of the Grecian army.

ANGEL-SHOT.—A shot formed of two hemispheres or spheres connected by a chain. It was invented by Admiral DeWitt, in 1666, and was formerly much employed for carrying away rigging in naval actions. It was sometimes fired from a cannon with two slightly diverging barrels united at the breech, forming a single chamber, and discharged through a single vent.

ANGLE.—The opening or inclination of two lines that cut or meet one another. If the lines are straight the angle is *rectilinear.* The magnitude of an angle depends, not upon the length of the lines or legs, but upon the degree of their opening. If the legs are supposed closed, like a pair of compasses, and then gradually opened till they come into one straight line, they form a series of gradually increasing angles; when half way between shut and straight they contain a *right angle.* Any angle less than a right angle is called *acute,* and one greater is called *obtuse.* Angles are measured by degrees, of which a right angle contains 90. The angle made by two curved lines (*curvilinear*) is the same as the angle made by the tangents to the two curves at the point of intersection. Angles made by planes with one another can also be reduced to rectilinear angles. When three or more planes meet at the same point, the angular space included between them is called a *solid angle.* The angles most frequently referred to in fortification, gunnery, etc., are: *angle of arrival, angle of clearance, angle of defense, angle of departure, angle of depression, angle of descent, angle of dish, angle of dispart, angle of elevation, angle of fall, angle of fire, angle of incidence, angle of inclination, angle of lock, angle of projection, angle of reflection, angle of sight, angle of spiral, dead angle, diminished angle, flanked angle, interior flanking angle, re-entering angle, salient angle,* and *terminal angle.*

ANGLE OF ARRIVAL.—The angle included between a tangent to the trajectory at the crest of the parapet and a horizontal line. Supposing *small* angles proportional to their tangents, we have these simple relations: 1. *At the same distance from the crest, the fall of the projectile is proportional to the angle of arrival;* 2. *For the same angle of arrival, the fall of the projectile is proportional to the distance from the crest.*

ANGLE OF CLEARANCE.—In gunnery, the angle of elevation obtained when the top of the tangent scale and dispart sight and the notch on the muzzle are in line.

ANGLE OF DEFENSE.—In fortification, the angle formed by a line of defense and a flank. The angles of defense should never be less than 90° and never more than 120°.

ANGLE OF DEPARTURE.—In gunnery, the actual angle which the shot's path on leaving the muzzle of a gun makes with the true horizon. This, when there is windage, may differ sensibly from the *angle of inclination,* and appears also to do so in the lighter rifled guns, where the shots are observed to rise, from the muzzle being slightly thrown up. This rise is caused from the "jump" of the gun.

ANGLE OF DEPRESSION.—In gunnery, the angle given to a piece of ordnance when laid under metal, or at an angle below the horizon.

ANGLE OF DESCENT.—In gunnery, the angle which the tangent to the trajectory makes with the horizon at the height of the crest of the parapet or other object to be cleared. It is rather less than the terminal angle.

ANGLE OF DISH.—The measure of the dish of a wheel, being the angle made by the spokes of the wheel with the plane of its face.

ANGLE OF DISPART.—The number of degrees the axis of the bore would point above the object aimed at when laid by the surface of the gun.

ANGLE OF ELEVATION.—In gunnery, the angle between the axis of the gun and the visual line from the sight on the tangent scale to the object. It has no reference to the horizon or to any natural level.

ANGLE OF FALL.—The angle which the tangent makes at the *point of fall* with the terre-plein. The size of this angle will determine the kind of ricochet. It will be grazing if the angle is 4° or less, and plunging when it is comprised between 6° and 10°.

ANGLE OF FIRE.—In gunnery, the angle which the axis of the barrel makes with the horizontal line; on account of the balloting of the projectile, the angle of fire is not always equal to the angle of departure, or projection.

ANGLE OF INCIDENCE.—In gunnery, the angle which the tangent to the trajectory makes with the actual surface struck at the point of descent.

ANGLE OF INCLINATION.—In gunnery, the angle which the axis of the gun forms with the true horizon, or the angle shown by a correct spirit-level. This is, consequently, the angle recorded when guns are laid by the quadrant.

ANGLE OF LOCK.—The angle included between the stock and the plane of the wheel, when the wheel touches the lock-plate in turning. The *angle of lock* with the 5' track is a little more than 50°.

ANGLE OF PROJECTION.—In gunnery, the angle which the tangent makes with the horizontal at the muzzle. See *Angle of Departure.*

ANGLE OF REFLECTION.—The angle intercepted between the line of direction of a body rebounding after it has struck against another body, and a perpendicular erected at the point of contact.

ANGLE OF SIGHT.—In gunnery, the angle included between the line of sight and line of fire. Angles of sight are divided into natural and artificial angles of sight, corresponding to the natural and artificial lines of sight which enclose them. See *Pointing.*

ANGLE OF SPIRAL.—This angle, sometimes called the *angle of rifling,* differs in different guns, depending principally on the length, weight, and muzzle-velocities of the projectiles fired from them. It is measured at any point of the groove, in guns rifled with *increasing twist,* by the angle which a tangent to the groove at that point makes with a line in the bore parallel to its axis; and in guns rifled with *uniform twist,* by the angle which the groove itself makes with a line in the bore parallel to its axis. In guns rifled with increasing twist, the angle of spiral at the muzzle is called the *final angle of rifling,* and that at the breech end of the rifling is called the *initial angle of rifling.*

ANGLE OF THE CENTER.—In fortification, the angle formed at the center of the polygon by lines drawn thence to the points of two adjacent bastions.

ANGLE OF THE EPAULE.—In fortification, the angle formed by one face and one flank of the bastion.

ANGLE OF THE FLANK.—In fortification, the angle formed by the flank and curtain.

ANGLE OF THE LINE OF DEFENSE.—In fortification, that angle made by the flank and the line of defense.

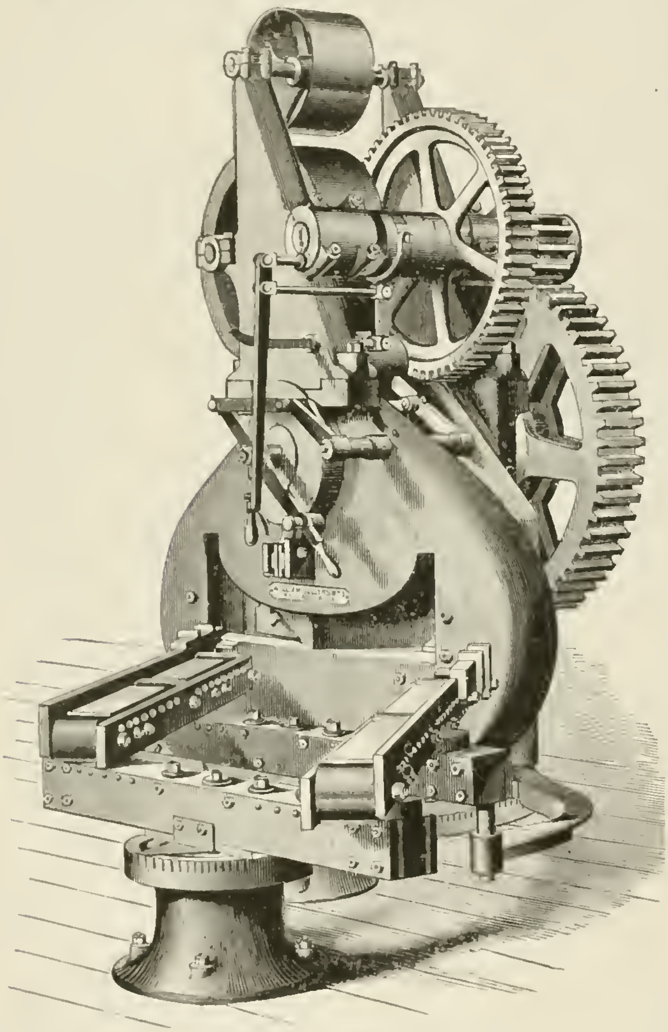
ANGLE OF THE POLYGON.—In fortification, the angle formed by the meeting of two sides of the polygon; it is likewise called the *polygon angle.*

ANGLE OF THE TENAILLE.—In fortification, the angle made by two lines fichant,—that is, the faces of the two bastions extended until they meet in an angle towards the curtain,—and is that which always carries its point towards the outworks.

ANGLE OF TRACTION.—In draught, the angle which the plane of the traces makes with the road on which the carriage is moving. Artillery carriages having sometimes to move over the worst description of roads, the angle of traction must be slightly inclined upwards, as the vertical component of the pull will then assist the wheels to surmount obstacles; the weight being transferred to the shoulders of the horse increasing the pressure of his feet upon the ground, thus giving him a firmer hold, and enabling him to exert with ease a stronger pull, while the resistance against which he contends is at the same time diminished.

ANGLE SHEARING-MACHINE.—A machine of frequent use in the Armory and Foundry. The same principle involved in lever shearing and punching machines obtains in this useful tool. Angles which have been curved or bent before shearing and while resting on trestles may be readily trimmed. The blades have no shear given to their edges; but by punching the angle off with a cut extending over all parts of the iron with a uniform pressure, the piece cut off is not bent out of shape. This is an important feature in the machine, as it enables it to be used in cutting up angles to length without distorting the ends cut off. Very much more rapid work can be done when the plates are moved by a spacing device than when laid out with a template and passed through the machine by hand; accordingly, dividing-machines can be adapted to the shearers and punchers to enable the sheets to be spaced mechanically, making proper allowance for the difference of diameter or circumference of outer or inner sheets in cylindrical work.

The drawing shows a Duplex Angle Shear, as made by William Sellers & Co. This is a most perfectly



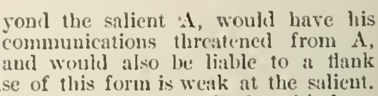
Angle Shearing-Machine.

contrived machine, and very effective in operation. The great weight of the machine is carried on a set of anti-friction rollers. This enables the machine to be turned to the required angle of cut, thus setting the blades to the angle, and not swinging the bars to be sheared to the same angle. This is a very important matter, as involving great economy in armory-room. There are two shearing slides to carry the movable or upper blades, and these are at an angle of 90° to each other, so as to cut the angles as they lie on their flat with one leg vertical, and to make the cut at any required angle of oblique division, from 30° angle to 90°. The machine, as represented, is operated by a heavy crank, which works either one of two diagonal slides carrying the cutting blades for right- or left-hand cutting. The bars are punched off at one stroke, so as not to distort the crop ends by any shearing motion of the blades, and the machine is powerful enough to cut 6 inches by 6 inches by 1 inch angles, and to make the cut at any angle required in bridge structures from 30° included angle to square. The machine is provided with guiding tables for the angles to rest on, and the entire machine, carrying its guiding tables with it, is made to swing on a center, so that the presentation to the machine of the angle to be cut is always in the same right line. This arrangement is very economical of room, as the irons taken from the pile are presented in line with the pile, the machine being turned to the required angle of cut, either to the right or the left hand. Pulley on the machine is 36 inches diameter, 12 inches face, and should make 300 revolutions per minute. The machine must be placed under the driving pulley of the line, and the belt is so carried by guiding pulleys on the machine and near to the line driver as will permit the vibration of the machine to its required angle of cut. See *Lever Shearing-machine, Power Shears,* and *Shearing-machine.*

ANGON.—A barbed spear used by many early nations. The Franks, in the seventh century, employed angons both for thrusting and hurling. The staves were armed with iron, so as to leave but little of the wood uncovered; the head had two barbs. When hurled or thrust at an opponent, the head of the angon became fixed in the flesh by means of the barbs. This form of spear was much adopted by the Anglo-Saxon and other Teutonic nations.

ANGUIS.—A flag adopted by the Romans, which was carried at the head of a cohort (the tenth part of a Roman legion, consisting of 600 men); this flag resembled a serpent in shape, and was more commonly called *draco.*

ANGULAR BASE OF OPERATIONS.—If the base is angular, the angle may be towards the enemy or away from him. If it is salient, as in the drawing, it is plain an enemy, EE, moving be-



yond the salient A, would have his communications threatened from A, and would also be liable to a flank attack. A base of this form is weak at the salient. The smaller the angle at A, or the farther this front is advanced beyond B and C, the weaker will the base be. The salient must therefore be strengthened, and made perfectly safe. A base of this form is, however, more favorable for an army acting on the defensive than for one acting offensively. For an army acting within the angle BAC can move from one part of the line to another, to reinforce any part of the line, more quickly than one on the exterior can. If the base instead of being salient is drawn back behind B and C, that is, forms a re-entrant, it will be more favorable for an army acting offensively than for an enemy acting defensively. For an army proceeding from a base of this form can threaten or seize the communications of its opponent without exposing its own.

ANGULAR VELOCITY.—The velocity of a body rotating round a fixed point, which is measured by the circular arc described by any point of the body at some unit of radial distance, usually one foot from the axis of rotation. The velocity of any particular point of a rotatory body may be found by multiplying its angular velocity by the radial distance of the point from the axis of rotation; and *vice versâ*, the angular velocity may be found by dividing the velocity of any known point by its radial distance.

ANGUSTICLAVE.—A robe or tunic embroidered with purple studs or knobs, and with narrow purple stripes, worn by Roman knights, to distinguish them from members of the Senatorian order, who wore a garment with *broad* stripes, called *latus clavus*.

ANIME.—A sort of ancient cuirass, also called *brigandine*. It was used in Italy until the seventeenth century, under the name of *anima* or *animetta*.

ANIOCRATER.—The highest military rank of the Lacedæmonians; one who commanded the whole army during the absence of the king.

ANIPPUS.—A name commonly applied to the light cavalry of the Grecians.

ANISOCYCLE.—An ancient machine of a spiral form, like the spring of a watch, used for throwing arrows to a great distance.

ANJON.—An ancient battle-axe frequently employed for missile purposes.

ANNALS.—A species of military history, wherein events are related in the chronological order in which they happened. They differ from a perfect history in being merely a relation of what passes every year, as a journal is of what passes every day.

ANNAMALLY.—The name of a forest in the southern part of India, which yields good teak timber; the wood is made use of for ordnance purposes in the Madras Presidency.

ANNATINÆ.—Transport-ships (so called by Julius Cæsar) in which were transported provisions, etc., to armies and fleets. Also called *Corbitæ*.

ANNE.—The Order of St. Anne was originally established in Holstein, and carried with the Princes of that country into Russia. It was made a Russian Order in 1796, and is now widely diffused.

ANNEALING.—When steel, after having been raised to a very high temperature, is suddenly cooled by immersing it in pure water, brine, or mercury, it becomes excessively hard and brittle, and while in this condition cannot be worked in any way. To remedy this difficulty, the steel is reheated, and allowed to cool very gradually, by which process it regains the properties of softness and malleability. This process of heating and slow cooling is called *Annealing*. Care must be taken not to overheat the steel, as that injures the metal by burning out some of the carbon. The steel is cooled in various substances, such as powdered lime, sand, cast-iron borings, dry saw-dust, or warm ashes; the sole object being to make the cooling as slow as possible, and also to protect the steel from the air. In the annealing of cast-iron the heat requires to be kept up much longer than with steel, and the iron must be well supported to prevent its warping or breaking. When annealed it is much more uniform in temper, and less liable to alter its figure by any subsequent exposure to a moderate heat.

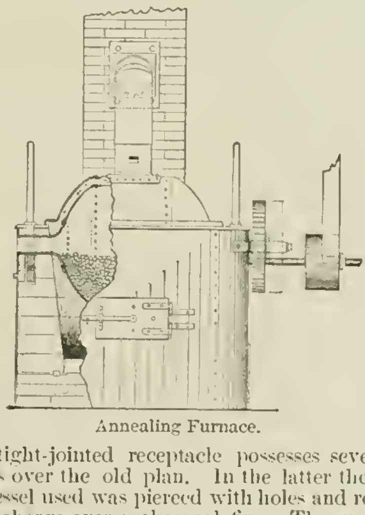
This property of becoming soft and malleable on being heated and slowly cooled is common to nearly all metals, *Copper* being the most marked exception. In working this metal the opposite course has to be pursued; that is, it is made softer and more flexible by plunging it when red-hot into cold water. When it is required *very* soft and the surface clean, a small quantity of sulphuric acid is mixed with the water.

The tempering of steel is really a process of annealing. The steel is placed in an oil-bath, or surrounded by a metallic mixture which has a low fusing-point; and according to the temperature to which it is subjected, a steel with various degrees of softness and strength is obtained. Parke's table of metallic mixtures capable of being used in the tempering or annealing of instruments made from steel is as follows:

	Alloy. Lead.	Alloy. Tin.	Fusing-point ° F.
Lancets	7 parts	4 parts	420
Razors	8 "	4 "	442
Penknives	8¼ "	4 "	450
" large	10 "	4 "	470
Scissors, shears	14 "	4 "	490
Axes, plane-irons	19 "	4 "	590
Table-knives	30 "	4 "	530
Watch-springs, swords	48 "	4 "	550
Large springs, augers	100 "	4 "	558

The theory of annealing is very imperfectly understood. A certain rearrangement of the atoms of the glass or metal no doubt takes place, and an absorption of heat occurs. It is possible that as the crystalline structure is indicative of brittleness, and the fibrous texture characteristic of strength, that the passage of glass or metal from a brittle to a non-brittle material may be due to the development of a fibrous structure, where a crystalline one was originally present. See *Steel* and *Tempering*.

ANNEALING FURNACE.—A furnace employed at Arsenals for annealing copper or brass shells, cannon-primer tubes, etc. The Annealing Furnace in use at Frankford Arsenal consists of the furnace proper, constructed of boiler-iron, lined with fire-brick, and arranged with flue and cold blast for draught and heat; of an annealing retort, cylindrical in shape, with closed ends of hemispherical form. From these ends project trunnions which revolve on friction rolls attached to the furnace. The left trunnion, looking toward the furnace, is hollow, and subserves several useful purposes. It is a peep-hole for observing the degree of heat to which the charge is being raised, an outlet for the smoke into which the oil on the shells is converted, a means of obtaining samples for test, and of emptying the charge when sufficiently annealed. The annealing accomplished



Annealing Furnace.

in this tight-jointed receptacle possesses several advantages over the old plan. In the latter the cylindrical vessel used was pierced with holes and revolved with its charge over a charcoal fire. The surface of the shells became considerably oxidized from exposure to the atmosphere and took up some dirt, as ashes from exterior surroundings, during the process. By the new plan the charge is protected from the direct action of the fire, and the gases and smoke generated and expanded inside the retort flow out through the hollow trunnion. By the old method charcoal was necessary as a fuel to guard against the sulphur and other gases which would be generated from burning anthracite coal. Anthracite coal is used with the new retort, and the shells are annealed with less oxidation of their surfaces, and consequently require less pickling and cause less wear upon machinery and tools in the continued process of drawing. Ten thousand shells or thirty thousand cannon-primer tubes is a full charge for the retort. A crane takes the retort from the furnace and deposits it upon a cradle from which it is readily emptied. The retort with full charge weighs about 600 pounds. The furnace has a hinged wrought-iron cover, which is lowered over the retort during the operation of annealing and raised when the retort is removed; also a hinged flue, which fits into an opening in the cover connecting it with the draft. The drawing on the preceding page shows the general construction and operation of the furnace.

ANNEAU D'OR.—A gold ring. In accordance with the example of the ancients, Francis I. of France instituted a military recompense in the shape of an *anneau* for all who distinguished themselves in any military enterprise.

ANNULAR-BIT.—A boring-bit which cuts a circular channel, but does not *rout* the central portion. Wads and other articles in the armory are made by a tool of this kind.

ANNUNCIADA.—1. The Religious Order of the Heavenly Annunciation, or of the Nuns of the Annunciation of Mary, was instituted by Victoria Fornare at Genoa in 1682, after the rule of St. Augustine. All the convents of the order in France, Germany, and the Netherlands have disappeared since the French Revolution. Some still exist in Italy. 2. Another Order of the Annunciation, or of Nuns of Mary's announcement or the ten virtues, was endowed by John of Valois at Bourges in 1501, after its separation from Louis XII. In 1514 it was placed under the authority of the Franciscans. This order, which extended to fifty convents for the reception of poor gentlewomen, was broken up at the Revolution. 3. The Order of Knights of the Annunciation in Savoy, *ordine suprema dell' annunciata*, known originally as the order of the neck-chain, or collar, was instituted in 1360 by Amadeus VI., Duke of Savoy. It received statutes from Amadeus VIII. in 1409; was renewed in 1518 under the name of the Holy Annunciation; and in 1720 was raised by Victor Amadeus to be the first order of the kingdom of Savoy. The King is always Grand Master. The knights, who, since 1720, are not limited in number, must be of high rank, and already admitted to the Orders of St. Mauritius and St. Lazarus. They compose only one class. The decoration is a gold medal, on which is represented the Annunciation, surrounded by love-knots. It is usually worn suspended by a simple gold chain; but the proper collar or chain of the order is composed alternately of love-knots and roses. On the roses are engraved the letters F E R T, which some interpret *Fortitudo ejus Rhodum tenuit*, in allusion to the defense of Rhodes by Amadeus I., and which others hold to signify *Frappes, entres, rompes tous.* Since 1680 the knights wear on the left breast a star embroidered in gold. The four supreme officers of the order—the Chancellor (always a Bishop or Archbishop), the Secretary (usually the Minister of Foreign Affairs), the Almoner (usually the King's First Almoner), and the Treasurer—wear the decoration round the neck, suspended by a sky-blue ribbon, accompanied by a star on the left breast.

Star of the Order of the Annunciation.

ANSÆ—ANSE.—The handles of certain kinds of ancient ordnance. Small pieces of light weight intended to be moved from place to place by hand, such as life-saving guns, are provided with *ansæ*. These handles, especially in some foreign cannon, are cast in the form of dolphins and serpents.

ANSPESSADE.—A term originally used to denote dismounted horsemen who were obliged to serve temporarily in the infantry, and who broke off the tops of their lances so as to reduce their length to that of the halberds of the sergeants. Also, a non-commissioned officer who acts subordinate to a corporal; a lance-corporal.

ANTECESSORES—ANTECURSORES.—Light cavalry of the Romans, which formed the advanced-guard of an army while on the march.

ANTE-MURAL.—In fortification, an outwork consisting of a high strong wall with turrets, for the defense of a gate.

ANTEPILANI.—Soldiers of a Roman legion who composed the first and second ranks in line of battle, and who were accordingly placed in front of the third rank. The first rank was called *hastati*, the second *principes*, and the third *pilani* or *triarii*.

ANTESIGNANI.—A name given to the soldiers of the Roman army who protected the colors, etc.; according to some authorities they were the *hastati* or *principes*, and according to others they were a select detachment consisting of picked soldiers.

ANTESTATURE.—A small intrenchment or work formed of palisades or sacks of earth.

ANTHONY.—The military order of the Knights of St. Anthony was instituted by Albert, Duke of Bavaria, Holland, and Zealand, when he designed to make war against the Turks in 1382. The knights wore a collar of gold made in the form of a hermit's girdle, from which hung a stick like a crutch, with a little bell, as they are represented in St. Anthony's pictures.

ANTHRACITE.—A mineral substance of the nature of coal, but consisting of carbon with a minimum amount of hydrogen. It is of a black color, conchoidal fracture, and imperfectly metallic luster (hence called *glance*-coal). It burns slowly and without flame, and hence is sometimes called *blind*-coal. Its vegetable origin cannot be doubted. Where strata of common coal have been broken through by trap-dikes, the coal next the trap is found to be anthracite, with a gradual transition into the ordinary state; hence geologists look upon anthracite as natural coke, formed by heat or other process from ordinary coal. Anthracite is used as fuel like coke. It is applied in many places to the burning of lime and bricks, the reduction of iron, etc. It occurs extensively in Ireland, and in some of the coal-fields of England, Scotland, and the Continent of Europe; but on the largest scale in the United States.

In 1776, anthracite from near Wilkesbarre, Penn., was floated down the Susquehanna to Carlisle, and was used in the Government Arsenal. In 1803, 100 tons were brought from Summit Hill to Philadelphia, and were sold to the City Government for use in the pumping-works, but the engineers did not know how to burn it, and it was broken up to gravel the walks in the yards. In 1812 two ark-loads were sold at the falls of the Schuylkill at $21 per ton. A morning was wasted in futile attempts to burn this coal, and at noon the workmen and their employer, discouraged at their ill-luck, shut up the furnace and went to dinner. On their return they were astonished to find a roaring fire, the furnace-doors red-hot, and the furnace itself in danger of melting. From that day dates the successful use of anthracite in America. The development of this interest is shown in the following table:

Anthracite is the purest form of natural carbon except the diamond. The carbon varies from 95 per cent, in specimens picked from the best veins, to 80 or 85 per cent. Coal containing less than 80 per cent of carbon is not classed as anthracite. The volatile matter present is water, oxygen, hydrogen, and nitrogen; the ash contains oxide of iron, iron pyrites, silica, alumina, lime, etc. Pennsylvania anthracites have usually 86 to 94 per cent of carbon, 1½ to 7 per cent of volatile matter, and 1½ to 7 per cent of ash; the

Years.	Wyoming Region. Luzerne and Sullivan Cos.		Lehigh Region. Carbon, Columbia, and Luzerne Cos.		Schuylkill Region. Schuylkill, Northumberland, Columbia, Dauphin, and Lebanon Cos.		All the Regions.
	Shipments.	Total prod't.	Shipments.	Total prod't.	Shipments.	Total prod't	Total prod't.
Ante 1820	....	10,000	......	3,000	... .	5,000	18,000
In 1829	7,000	16,800	25,110	29,110	78,293	87,293	133,203
1839	122,300	146,760	221,025	265,230	454,538	545,446	957,436
1849	732,910	862,635	781,656	920,009	1,650,101	1,942,168	3,724,812
1859	2,731,236	3,151,846	1,628,311	1,879,071	3,448,708	3,979,809	9,010,726
1869	6,068,369	7,279,543	1,929,523	2,313,989	5,653,855	6,782,146	16,375,678
1879	12,575,000	13,300,000	4,550,000	4,825,000	9,125,000	9,670,000	27,825,000
	153,863,765	172,944,369	71,580,696	80,687,227	154,090,548	174,356,236	427,987,882

density varies from 1.4 to 1.63. Anthracite was derived from bituminous coal by heat acting under great pressure, and probably caused by pressure in the geological changes which threw the anthracite regions, as in eastern Pennsylvania, into great mountain-waves. The heat drove off all volatile matters which it would develop from the bituminous coal, and left the more stable material behind as a natural coke, differing from artificial coke only in its superior density. The loss of vegetable matter by decomposition in the formation of bituminous coal is estimated at about three fifths of the material, and in the production of anthracite at about three fourths; the added compression leaves the resulting bulk about one fifth or one eighth the original mass. It follows, then, that to produce a vein of anthracite 30 feet thick, 240 feet of vegetable matter must have existed. The coal-deposits, as found in the anthracite formation near Pottsville in the Schuylkill valley, include 15 groups, with 30 beds or veins more than 2 feet thick, and 20 seams less than 2 feet. The thickest, or mammoth vein, is a single bed from 20 to 70 feet thick, in some places divided into three layers by seams of slate. About four fifths of the present production of anthracite comes from this vein. The aggregate thickness of the coal-veins at this point is 113 feet, of which 80 feet may be profitably mined.

The possibilities of the production of anthracite in America may be gathered from the following table:

The Area and Contents in Coal of the Anthracite Basins of Pennsylvania.

Field.	Area.		Feet of coal.	Quantity of Coal.		Per cent.
	Square miles.	Acres.		Per A., tons.	Total quantity, tons.	
Wyoming	186	118,500	19	34,580	4,097,730,000	36
Lehigh	43¾	28,000	20¼	36,855	1,030,120,000	99
Schuylkill	215	137,500	25	45,500	6,256,250,000	55
Total	373¾	284,000	64¼	116,935	11,384,100,000	100

Field.	Tons sold to end of 1877.	Tons mined, including waste.	Tons remaining.	Per cent.	Tons available, allowing waste.	Per cent.
Wyoming	151,475,872	60 per ct. waste. 378,689,680	3,719,040,320	36	50 per ct. waste. 1,859,520,160	41
Lehigh	72,422,227	65 per ct. waste. 206,910,302	823,209,698	8	60 per ct. waste. 329,283,879.2	7
Schuylkill	157,776,236	65 per ct. waste. 450,766,703	5,805,483,297	56	60 per ct. waste. 2,322,193,318.8	52
Total	381,674,335	1,036,366,685	10,347,733,315	100	4,510,997,358	100

See *Coal* and *Coke*.

ANTI-CORROSION.—A lacker formerly applied to iron traversing-platforms, gun-carriages, and the outside of guns. It has been superseded by Pulford's magnetic paint.

ANTIMONY.—A metal of a gray or leaden color, and very brittle. It is found in mines with *galena*, or the sulphuret of lead, from which it is easily distinguished, the antimony occurring in fine streaky fibrous crystalline masses of a radiated texture, whereas sulphuret of lead is of a smooth, shiny, laminated nature. Antimony is found in Cornwall, France, Spain, Borneo, Nepal, the Straits, and Siam, and is commonly associated with iron, zinc, quartz, silver, sulphate of baryta, and carbonate of zinc. It fuses at about 800 Fahr., and volatilizes very perceptibly at a somewhat higher temperature. It is one of the ingredients used in the detonating composition of friction-tubes, and stars for signal-rockets. When mixed with lead, it has the property of hardening bullets. Sulphide of antimony enters into those compositions employed to give a strong light. It is particularly well suited for that purpose, for being decomposed at a comparatively low temperature, the metal is set free and disseminated through the flame in a state of incandescence, causing the intensity of the light to be considerable; moreover, the heated particles, coming in contact with the atmosphere, are thereby oxidized, forming a white smoke which is very favorable to the reflection of light.

ANTUSTRIONES.—A body-guard of the Kings or Chiefs of the ancient Germans, which was composed of volunteers.

ANVIL.—1. An iron block, with a smooth, flat steel face, on which malleable metals are hammered and shaped. Anvils are of all sizes, from the tiny articles used by watchmakers to the immense masses for trip-hammer work in great iron-foundries. The common anvil of blacksmiths has a cone or horn at one end, and a socket for a chisel in the other. The best anvils are made of cast-iron, faced with steel, the steel being placed at the bottom of the mould and the iron poured upon it. 2. The resisting cone, plate, or bar against which the fulminate in a metallic cartridge is exploded. 3. An archaism for the handle or hilt of a sword. Also, a small pennon on the end of a lance.

APAREJO.—The pack-saddle used in the American military service. It consists of a strong leather sack, about two feet wide and from 55 to 60 inches long, according to the girth of the animal. A seam running from the front to the rear of the aparejo divides it into two equal parts, each of which is composed of a double layer of hide, with sufficient space between to introduce a suitable stuffing of hay, grass, moss, fiber, etc. These side flaps, when fastened together at the top, form a ridge within which the back-bone of the animal rests free from friction or pressure. On the inside of each flap is left a circular hole through which the stuffing material can at any time be reached.

The careful packer should keep the stuffing evenly distributed, or so as to vary with the conformation of the back of the particular animal, as portions of it are constantly shifting and working up into lumps, in consequence of the travel. The drawings show the interior and exterior of the aparejo. To *set up* the aparejo, or to give it evenness and stiffness, small ash, rose, or willow sprouts from ½ to ⅜ of an inch in

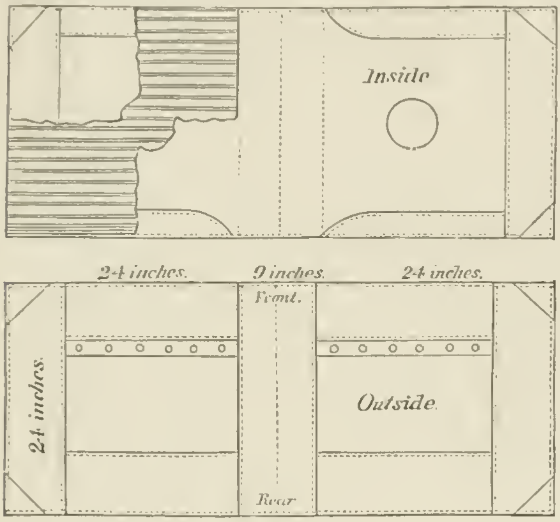


Fig. 1.

diameter, and as long as possible without springing (any tough and elastic wood will answer), are placed inside of it and at equal distances apart—about 2 inches. On the inside of these, and towards the animal, coarse grass or hay (such as is light and tough and will not break up) is placed layer after layer until the sides are as full as possible. The corners should be stuffed as hard as possible by means of a sharp stick. Serious trouble is often experienced on

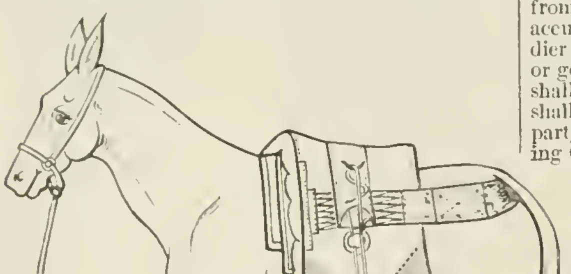


Fig. 2.

long and toilsome marches from loss of flesh, causing the aparejo to fit badly and cause a sore back. Great care must be taken to make good all deficiencies in the stuffing, and when the aparejo is too large to be adapted to a thin animal by stuffing, a portion should be cut out of the center. Straw pads are useful for protecting the hips and withers when placed under the cinches of those animals carrying rough loads. When the aparejo is stuffed it should be put on the animal for which it is intended, and the crupper adjusted. Fig. 2 represents the animal saddled with the crupper in proper position. The shape of the aparejo enables all loads to be nicely balanced. One hundred pounds on one side may be made to ride with fifty pounds on the other without straining the animal. It presents much more surface for pressure to the animal than any other form of pack-saddle. The lower corners secure the lash-rope and prevent it slipping when on the road. By removing the hay or stuffing from the sides a sore back may be easily remedied, and by properly adjusting the filling, the aparejo may be made to perfectly fit a badly shaped back. These may be cited as some of its advantages. See *Packing.*

APAREJO-CINCHA.—A girth made of hide or strong canvas, about six feet long and twenty inches wide, and folded so as to bring the edges in the centre of the cincha. A semicircle of strong leather pierced with several holes is stitched on one end, and two loops of strong leather on the other. See *Hammer-cloth* and *Packing.*

APEX.—The tip, point, or summit of anything. The Romans so named the crest of a helmet, or the part whereon the horse-hair plume was attached.

APHRACTI.—In the ancient military art, open vessels, without decks or hatches, furnished only at head and stern with cross-planks, whereon the men stood to fight.

APOBATES.—A name given by the ancients to warriors who fought mounted on chariots; they were also called *Andabatæ* or *Parabates;* they were generally leaders who fought in this manner. Their armor and arms consisted of helmet, breast-armor, lance, javelin, sword, and shield. These warriors occasionally alighted from the chariots to attack their adversaries on foot.

APOLOGY.—In a military point of view, an apology made and accepted debars the officer who accepts from bringing forward the matter as a substantive accusation. The law declares that no officer or soldier shall use any reproachful or provoking speeches or gestures to another. Any officer who so offends shall be put in arrest. Any soldier who so offends shall be confined, and required to ask pardon of the party offended, in the presence of his Commanding Officer.

APOMAQUE.—A word, among the Grecians, signifying those soldiers who were disqualified for military service from physical disability or other causes.

APOMECOMETER.—An instrument used for measuring heights, constructed in accordance with the principles which govern the sextant, viz.: As the angles of incidence and reflection are always equal, the rays of an object being thrown on the plane of one mirror are from that reflected to the plane of another mirror, thereby making both extremes of the vertical height coincide exactly at the same point on the horizon-glass, so that by measuring the base-line we obtain a result equal to the altitude. The eye of the observer when in position will be at the lower end of the hypothenuse, and the summit of the object at the other. Keeping the line of vision, which forms the base, exactly horizontal, the observer approaches the object till the images coincide, when the base will agree in length with the perpendicular, and the measured length of the former will give the height of the latter.

APPAREILLES.—In fortification, those slopes that lead to the platform of the bastion.

APPASTIS.—A war tax which was levied in ancient times upon the inhabitants of conquered countries. Also known as *Pactis*.

APPEAL.—Any officer or soldier who may think himself wronged by his Colonel or the Commanding Officer of his regiment, and after due application to him is refused redress, may appeal to the next higher commander, who is to examine into said complaint and take proper measures for redressing the wrong complained of, and transmit, as soon as possible, to the Department of War a true statement of such complaint, with the proceedings had thereon. If any inferior officer or soldier shall think himself wronged by his Captain, or other officer, he is to complain thereof to the Commanding Officer of the regiment, who is required to summon a Regimental Court-Martial for doing justice to the complainant; from which Regimental Court-Martial either party may, if he thinks himself still aggrieved, appeal to a General Court-Martial. But if upon a second hearing the appeal shall appear vexatious and groundless, the person so appealing shall be punished at the discretion of the said Court-Martial.

The wrongs here alluded to have reference chiefly to matters of accounts between the Captain, or Commander of the company, and the soldier, relating to clothing and other supplies, as well as to pay; and the Regimental Court, in examining into such transactions, may be considered more as a Court of Inquiry than a Court-Martial, or it may be viewed as an Arbitration Board, called on to adjust and settle differences arising in the settlements of accounts between the Captain and his men. One reason why a power of appeal is declared to be a matter of absolute right to inferior officers or soldiers complaining of being wronged by their officers doubtless is, that a Regimental or Garrison Court-Martial has not the power of inflicting any punishment on Commissioned Officers. It can do no more than express its opinion that the complaint is just, or the contrary, and, where it is practicable and proper, relieve the sufferer as to any existing grievance; but the injury complained of, however flagrant, must still have remained unredressed, as far as punishment is concerned, if an appeal to a General Court-Martial had not been declared to be a matter of right to the party aggrieved.

APPEL.—A smart stroke with the blade by a fencer, on the sword of his antagonist on the opposite side to that which he engaged, generally accompanied with a stamp of the foot, and used for the purpose of procuring an opening.

APPOINT.—To fix by a decree, order, command, resolve, decision, or mutual agreement. In the United States the President, by and with the advice and consent of the Senate, appoints and commissions all Commissioned Officers of the Army. Appointments to the rank of General Officer are made by selection from the Army. All vacancies in the grade of Second Lieutenant are filled by appointment from the graduates of the Military Academy, so long as any such remain in service unassigned; and any vacancies thereafter remaining are filled by promotion of meritorious Non commissioned Officers of the Army. Vacancies remaining after exhausting the two classes named are filled by appointment of persons in civil life. But appointments of civilians, except such as are regular graduates of the Military Academy who have been honorably discharged from the service, are made in time of peace only when more vacancies exist in the Army than will be required in the assignment of the next graduating class. To insure the selection of proper *Candidates for Promotion* from the grades of Non commissioned Officer, Company Commanders report to their Regimental Commanders, by the first of February in each year, such as, in their opinion, by education, conduct, and services, seem to merit advancement, and who have served not less than two years in the Army. The reports set forth a description of the candidate, his length of service as Non-commissioned Officer and as Private Soldier, his character as to fidelity and sobriety; his age, physical qualifications, and mental abilities; the extent to which his talents have been cultivated, and his fitness generally to discharge the duties of a Commissioned Officer. If recommended on account of meritorious services, the particular services referred to are stated in detail. A qualified Board is annually assembled to make a preliminary examination into the claims and qualifications of such Non-commissioned Officers, and the report of this Board is forwarded to the Secretary of War.

Whenever the public service may require the appointment of a civilian to the Army, a Board of Officers is instituted, before which the candidate is authorized by the Secretary of War to appear for examination into his physical ability, moral character, attainments, and general fitness for the service. As a rule, promotions of Non-commissioned Officers to the rank of Second Lieutenant will not be made if the candidate is under twenty-one or over thirty years of age, nor if the candidate at the time of his appointment is married. The limits of age in cases of civilian candidates are twenty and thirty years. Meritorious Non-commissioned Officers of the Army recommended for appointment receive a certificate to that effect from the Adjutant-General of the Army, and are known in the service as "Candidates for Promotion," and have the title of "Candidate" prefixed to that of their rank on all rolls, returns, orders, and correspondence. They are entitled to wear on each sleeve of their coat a single stripe of gilt lace, but are entitled to this privilege so long only as they maintain the specially honorable position of "Candidate." The privileges of a candidate terminate with the calendar year next succeeding that in which he receives his "Certificate," unless his recommendation is continued by the succeeding Boards of Examination. Candidates who become ineligible by reason of over-age are entitled to wear the candidates' stripe on the *left* sleeve only, so long as they maintain the same standing and good conduct as Non-commissioned Officers in the service as at their examination. "Candidates" who think themselves wronged in the loss of that position have a right to trial by General Court-Martial on appeal, within two months, to the Department Commander; and no Non-commissioned Officer, while holding the privileges of a "Candidate," can be brought before a Field-officers' Court, or a Garrison or Regimental Court-Martial. All vacancies in established regiments and corps to the rank of Colonel are filled by promotion according to seniority, except in case of disability or other incompetency. Promotions to the rank of Captain are made regimentally; to Major and Lieutenant-Colonel and Colonel, according to the arm, as Infantry, Artillery, etc.; and in the Staff Departments, and in the Engineers and Ordnance, according to Corps. Suspension from rank prevents an officer's promotion to a higher grade, but will not otherwise prejudice his relative advancement by seniority in the grade occupied for the time being. See *Promotion*.

APPOINTE.—This word was applicable to French soldiers only during the old monarchy of France, and meant a man who for his service and extraordinary bravery received more than common pay. There were likewise instances in which officers were distinguished by being styled *Officers Appointes*.

APPOINTING POWER.—It has been contended by advocates of executive discretion that army appointments are embraced in the power granted to the President in the second section of the Constitution, to nominate and, by and with the advice and consent of the Senate, appoint "all other officers of the United States whose appointments are not herein otherwise provided for and which may be established by law. But the Congress may, by law, vest the appointment of such inferior officers as they think proper in the President alone, in the Courts of Law, or in the Heads of Departments." If due regard, however, be paid to the words, "*whose appointments are not herein otherwise provided for*," the pretension set up in favor of executive power will receive no support from the terms of the Constitution. The powers granted to Congress to *raise* and support armies, and to make all *rules* for the *government* and *regulation* of the land and naval forces, are necessarily so comprehensive in character as to embrace all means which Congress, according to circumstances, may deem proper and necessary in order to raise armies, or to govern them when raised. Rules of appointment to office, rules of promotion—another form of appointment—and all rules whatever in relation to the land and naval forces, save the appointment of the Commander-in-Chief of those united forces, who is designated by the Constitution, are hence within the competency of Congress.

It is true that this great power vested in Congress has been exercised by them, in most cases, by giving to the President a large discretion in appointments and other matters connected with the army. But the principle itself—that supreme command is vested in Congress—has been often asserted in our military legislation. Contemporaneously with the foundation of the government laws have been passed giving to general and other officers the right of appointment to certain offices; in other cases the President has been confined in his selection to classes designated by law; again, rules have been made by Congress for the promotion of officers, and in 1846 an army of volunteers was raised by Congress, the officers of which Congress directed should be appointed according to the laws of the States in which the troops were raised, excepting the General Officers, who were to be appointed by the President and the Senate—a clear recognition that the troops thus raised were United States troops and not militia. See *Appoint*.

APPOINTMENT.—Office, rank, or employment. Also, the equipment, ordnance, furniture, and necessary articles of an army.

APPOINTMENTS.—The military accouterments of officers or soldiers, such as belts, sashes, swords, etc. In the English service the *appointments* in the mounted branch consist of accouterments, saddle, etc., making, with the Non-commissioned Officer, a total weight for the horse to carry of about 18 stone.

APPOINTON.—A sort of poniard which was extensively used in ancient times.

APPREHEND.—In a military sense, the seizing or confining of any person; as, to apprehend a deserter, etc.

APPRENTI.—Formerly in the French service there were *apprenti* or soldiers among the artillery, who served for less pay than the regular artillerymen, until they became perfect in their profession, when they were admitted to such vacancies as occurred in their respective branches.

APPROACH.—The route by which a fortified place or military position can be approached by an attacking force.

APPROACHES.—The successors of Vauban followed up, as far as practicable, the methodical stages in conducting the attack founded upon his long experience, and which consisted in a single or a double connected attack; approaching the points assailed by as many lines of communication, directed upon them, as circumstances seemed to demand, and protecting these approaches by three continuous main lines of trenches, termed the parallels, and several portions of parallels, termed demi parallels, placed between the second and third parallels, all of them so placed as to be in good tactical relations to each other.

The approaches were usually run in zigzag directions towards the salients of the defences, crossing the lines of the capitals of these salients; the front of each approach gradually contracting as it was advanced towards the salient; and each boyau of the approach receiving such a direction as not to expose it to an enfilading fire from any point of the defences within cannon-range. The drawing shows the profile of the approach. In addition to the communications between the parallels, two or more lines of approaches were run, from the positions selected for the depots of the trenches, to points of the first parallel convenient for the supplies for this and the other lines of works. These were also usually run in the direction of the capitals of some two or more of the salients.

Besides giving the boyaux directions unfavorable to an enfilading fire from the defences, each one is extended some ten or twelve yards back, to the rear of the one behind it, so that should the besieged endeavor to take up a temporary position, exterior to his main defences, each boyau would still be covered by the portion of the one in advance of it run to the rear, not only from an enfilading but from any slant reverse views, except from points so far beyond the defences as to make their temporary occupation very perilous to the besieged, from their exposure to open assaults.

The positions given to the approaches along the capitals are not obligatory; but will generally be found to offer more advantages than any other that

The Profile of the Approach.

could be given them on ground entirely unobstructed. In the first place, the capitals are the shortest lines from the parallels to the salients of the defences. In the second, by running the boyaux across the capitals, and gradually diminishing the extent of their front, the entire approach will be better flanked by the fire of the parallel in its rear; will be in a position to receive but little if any of the fire which is delivered from the two faces of the salient upon which it is run; will be out of the line of fire of the batteries enfilading these two faces; and will usually be in the most favorable position to defile each boyau from the fire of the besieged.

The front occupied by each approach will depend upon the length given to each boyau. As a general rule, the boyaux should not receive a greater length than 100 yards, in order not to expose too long a line to tempt the besieged to enfilade it, and the approach may be started at the first parallel with a front of 60 yards, which should be gradually narrowed, so as to have a front of about 30 yards at the position of the third parallel.

APPROPRIATIONS.—Annual appropriations, originating in the Lower House of Congress, are made for the support of the United States army. The English army is raised by the Queen, and maintained by annual appropriations by Parliament; the system for the support of armies is much the same throughout Europe. In the United States the term *appropriation* is also used by Post and Regimental Councils of Administration in the expenditure of funds.

APPUI.—A stay or support. In military tactics, the *points d'appui* are such parts of the field of battle as are suited to give support or shelter. As the wings of an army (like the extreme sides of a chess-board) are the weakest points of resistance to attack, they especially require support or protection, and are placed, when it is possible, in localities which serve to obstruct the attacking forces. Lakes, morasses, woods, streams, and steep declivities may thus serve as *points d'appui*.

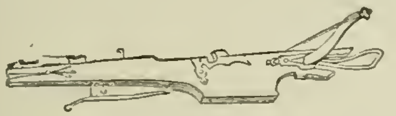
APRON.—This word is employed both in military and in shipping affairs. The apron of a cannon is a piece of sheet-lead which covers the touch-hole, tied by two pieces of white rope. In ship-building, the apron is a piece of curved timber fixed behind the lower part of the stem and just above the foremost end of the keel; its chief use is to fortify the stem and connect it more firmly with the keel. The name of apron is also given to the plank-flooring raised at the en trance of a dock, a little higher than the bottom, to form an abutment against which the gates may shut.

AQUEDUCT.—An artificial course or channel by which water is conveyed along an inclined plain. When an aqueduct is carried across a valley it is usually raised on arches, and where elevated ground or hills intervene a passage is cut, or, if necessary, a tunnel bored for it. Aqueducts were not unknown to the Greeks; but there are no remains of those which they constructed, and the brief notices of them by Pausanias, Herodotus, and others do not enable us to form any distinct notion of their character. The aqueducts of the Romans were amongst the most magnificent of their works, and the noble supply of water which modern Rome derives from the three now in use, of which two are ancient, gives the stranger a very vivid conception of the vast scale on which the ancient city must have been provided with one of the most important appliances of civilization and refinement, when nine were employed to pour water into its baths and fountains.

AQUILA.—The principal standard of a Roman legion. The standard of Romulus is said to have consisted of a handful of hay, straw, or fern, affixed to a pole or spear; whence the company of soldiers who served under it was called *Manipulus*. This primitive standard was soon superseded by the figures of animals. In 104 B.C. the Eagle was permanently adopted: it was made of silver or bronze, and was represented with expanded wings.

AQUILIFER.—A name given by the Romans to the officers who carried the Eagles of the legions.

ARBALEST—ARBLAST—ARCUBALEST.—A weapon much in use during the feudal times. Its recognized position among military arms may be dated from about the period of Richard I. The smaller kinds of arbalest were bent by pressing the hand on a small steel lever called the "goat's foot;" but the larger kinds were bent by placing the foot in a loop or stirrup at the end of the central shaft, and drawing the cord upwards with the hand. At a later period the bow was made very strong, often of steel; in this form it required a mechanical contrivance, called a "moulinet," to bend it. Sometimes ordinary arrows were used with the arbalest, but more usually arrows of a shorter and stouter kind, called "carrials" or "quarrels," were employed; these had a four-sided



Arbalest.

pyramidal form of head. Occasionally stones and leaden balls were shot from the larger arbalests. The Arbalestiers, or Cross-bowmen, carried a quiver with fifty arrows as an armament in some of the battles of the thirteenth century. They were an essential component of armies of that period, taking up their position in the van of the battle array; some were mounted, some on foot, and they occasionally wore armor. The supply of arrows or quarrels was carried after them to the battle-field in carts. The arbalest continued to be a favorite weapon in England throughout the thirteenth century; but in the fourteenth it gave way to the long-bow, which was found to be a more convenient weapon in battle.

ARBALESTINA.—In the military system of the Middle Ages, the arbalestina was a small window or wicket through which the Cross-bowmen shot their quarrels or arrows at an enemy besieging a fortified place.

ARBALETRIER D'UNE GALERE.—That part of a galley where the Cross-bowmen were placed during an engagement.

ARBRIER.—A short bow adjusted to a staff, and fixed at right angles to it, near one extremity. It was the *Arblast* in its elementary form.

ARC.—Any part of a curved line. The straight line joining the ends of an arc is its *chord*, which is always less than the arc itself. Arcs of circles are *similar* when they subtend equal angles at the centers of their respective circles; and if similar arcs belong to equal circles, the arcs themselves are *equal*. The length of an arc is readily found if the angle which it subtends at the center of the circle is known, and also the length of the whole circumference. Let the whole circumference be 100, and the angle of an arc 50°, the length of the arc is

$$360^\circ : 50^\circ : : 100 : \frac{100 \times 50}{360} = 14 \text{ nearly.}$$

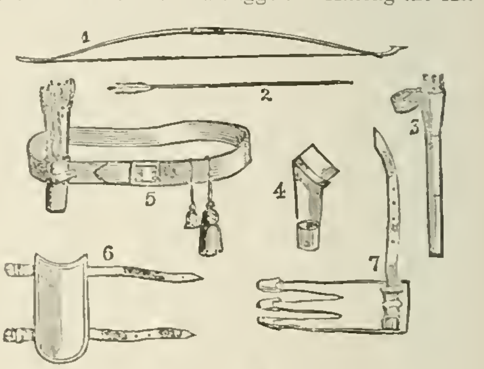
ARC À JALET.—A small cross-bow, used in ancient times to throw bullets, etc.

ARCH.—An arrangement of bricks, stones, or other materials over an open space, by which they are made not only to support each other by mutual pressure, but to sustain a superincumbent weight. We have the excellent authority of Sir G. Wilkinson for stating that the arch was known to, and used by, the ancient Egyptians; and that the Assyrians were acquainted with its principles is placed beyond doubt by the arched gateways so frequently represented in their bass-reliefs. The arch is generally supposed to have been unknown to the Greeks—a supposition which becomes very improbable if we hold it to be proved that it was used by nations with whose works they must have been familiar. But that the Greeks did not employ it generally in their architectural structures is certain; and as it is not less certain that the Romans did, it is to the latter people that the nations of modern Europe are indebted for their acquaintance with its great utility. The introduction of the arch by the Romans gradually effected a complete revolution in the architectural forms which they borrowed from the Greeks. The predominance of horizontal lines gave way by degrees, till, as the Romanesque passed into the Gothic style, it was superseded by the segments of a circle, placed generally more or less in a perpendicular direction. In its earliest application by the Romans, the arch did not spring from the

Triumphal Arch of Constantine at Rome.

entablature of the columns, but was generally placed behind them, and rested upon separate imposts. Subsequently this arrangement was departed from, and the arch assumed the position which it has since retained above the columns; sometimes having an entablature interposed, and sometimes rising directly from the capital of the column or pier, as in the Romanesque. Before mentioning very briefly the different forms of the arch, it seems natural to refer to a very simple structure, frequently met with in those early edifices in our own country which we are in the habit of designating as Saxon. It consists of two stones, their lower ends resting on rude piers, their tops leaning against each other, and thus forming two sides of a triangle, which is capable of supporting a moderate superincumbent weight. The mechanical principles on which the arch depends, though here very imperfectly employed, seem sufficiently called into play to suggest their more extensive application; and it is not impossible that out of this rude construction the arch, in its later and more elaborate forms, might have developed itself amongst ourselves without hints from foreign sources. Of the arch itself, the following variations of form may be enumerated: the semicircle, the segment, the ellipse, which were the only forms employed by the ancients, and which alone were known in mediaeval architecture up to the time at which the pointed arch was introduced. Of these, the stilted arch and the horseshoe-arch are modifications, in both of which the center or point from which the arch is described is above the line of the impost, but in the former of which the mouldings are continued downwards vertically; whilst in the latter they are slightly inclined inwards, or the curve is prolonged till it meets the impost. The horseshoe-arch belongs peculiarly to Arabian architecture, not only from its having originated simultaneously with the faith of the Prophet, but from its continuing to be used exclusively by his followers. Next in point of time, though far surpassing all the others in beauty and variety, is the pointed arch, the origin of which is still a subject of antiquarian controversy. The greater or less acuteness of the pointed arch depends on the position of the two center points from which its curved sides are described. Of the foil-arches, or arches in which the forms of a leaf are imitated, may be mentioned the trefoil, the cinquefoil, and the polyfoil, the latter being met with in Arabian and Romanesque buildings. At a later period of Gothic architecture, with the decorated style, the ogee arch was introduced, and the Tudor or four-cornered arch appeared about the commencement of the perpendicular style. When first introduced, the proportions of this arch were bold and effective; but it was gradually depressed till the principle of the arch was lost, and its very form was again merged first in two and then in one flat stone or lintel over an opening. With the last form of the Tudor arch we thus reach almost the point of departure in the construction of the arch, and complete our enumeration of its forms. The sides of an arch are termed *haunches* or *flanks*, and its highest part is called the *crown*. The wedge-shaped stones, bricks, or other materials of which an arch is constructed are called *voussoirs*; the uppermost one of all is called the *keystone*; the lowest, which is placed immediately over the impost, the *springer*, or springing-stone; the under or lower side of the voussoirs, the *intrados*; the upper side, the *extrados* or *back*. Arches are variously constructed and employed in military architecture.

ARCHERS.—Archers are soldiers whose weapons are the bow and arrow. Among the ancients specially eminent in this mode of warfare, we may particularize the Thracians, Cretans, Parthians, and Numidians; among the moderns, the Arabians, Germans, and Saracens. The Emperor Frederick II. employed Saracenic archers with great effect in his Lombard campaign; and to them is ascribed the victory at Cortenuova in 1237. The archers belonged to the light troops, and their province was to open the battle. The Emperor Leo especially lauded the dexterity of the Arabian archers. In later ages the bow came to be employed in England, where the archers wore light armor, a short sword, and a quiver with twenty or more arrows. At first these archers fought in small groups; in later years, in large masses. At the battle of Cressy they formed in divisions of 4000 men, 200 in line and 400 deep. The archers decided the fate of the day in several battles—such as Cressy and Poitiers (1356), Agincourt (1415), Crévaut (1423), Verneuil (1424), and Rovernay (1429). The French archers never equalled the English, in spite of the pains Charles VI. and Charles VII. took with them. The latter organized in 1448 the *Franc-archers*, to which corps every parish had to contribute one man; but this measure was attended with so little success that the king was induced to take Scottish archers into his pay, to make any head against the English. The French archers wore a coat of buffalo-hide lined with strong linen, and were accompanied by shield-bearers. In this manner 2000 bowmen with their shield-bearers fought under the Count de Foix at the siege of Bayonne in 1451. The archers universally belonged to the *élite* of the troops, and received higher pay than the rest. At one period the arbalest, or cross-bow, was more in favor than the long-bow. Long after the discovery of gunpowder we find the bow and arrow still used; as, for example, at the siege of Capua in 1500, and the siege of Peineburg in 1502. Nay, even in 1572 Queen Elizabeth promised to place at the disposal of Charles IX. 6000 men, of whom the half were archers. In a treatise on martial discipline, by Ralph Smithe, written in the time of Queen Elizabeth, we have a picture of the English archer two centuries after Chaucer's time: "Captens and officers should be skilful of that most noble weapon the long-bow; and to see that their soldiers, according to their draught and strength, have good bowes, well nocked, well strynged, everie strynge whippe in their nocke, and in the middes rubbed with wax braser, and shutting-glove, some spare strynges trymed as aforesaid; every man one shefe of arrows, with a case of leather defensible against the rayne, and in the same four-and-twenty arrowes, whereof eight of them should be lighter than the residue, to gall or astonye the enemye with the hailshot of light arrowes before they shall come within the danger of their harquebus shot. Let every man have a brigandine or a little coat of plate, a skull or hufkyn, a maule of leade of five foote in lengthe, and a pike, and the same hanging by his girdle with a hook and a dagger." Among the Asi-



Archery Apparatus.

atic Turks, the Persians, the Tartars, and other nations of the East, as well as the American Indians, the bow and arrow are still used as weapons of war. In Europe they are nearly abandoned for military purposes.

Although archers are still included among the fighting-men of barbarous and semi-barbarous nations, archery is now nothing more than a pastime, encouraged by Archery Clubs or Societies. In this sense, however, archery is experiencing a revival, being healthful as an out-door exercise, even if no further useful. During the reign of Charles II., archery was much patronized by the Court, Tothill Fields being the chief scene of exercise. After his reign archery fell into desuetude for about a century. In 1776, a Mr. Aston revived archery in the neighborhood of London; and very shortly there were several Toxopholite or Archery Societies formed. The system survived till 1793, when another period of inactivity supervened, lasting till 1844. In this last-named year archery was revived in Yorkshire, and has since gone on extending every year. A recommendation to the sport is that ladies can take part in it—one of the few open-air pastimes of which this can be said. In the modern exercise of archery there are several varieties of contests between the antagonistic parties; but the usual variety is target-shooting. In archery-matches a number of prizes are generally awarded, the principal being for the greatest number of arrows shot into any part of the target, and for the nearest approach to the exact center. The target has a gold spot in the center, a red ring around this, then a blue ring, then a black, and outside of all a white ring bordered with green. The merit of the shooting consists in a near approach to the exact center, or "gold." Two targets are generally used in a match, on opposite sides of the field, each by one party. The apparatus mostly used at these archery-meetings is: 1, the bow, varying in weight according to the strength of the person who is to use it; 2, the arrow; 3, the quiver, a tin case for holding arrows not immediately in use; 4, the pouch; 5, the belt for holding the arrows actually in use. The tassel of the belt serves to clean the arrows when dusty. 6, the brace, buckled round the left arm, to protect it from being hurt by the string when shooting; 7, the shooting-glove, formed to protect the three fingers used in drawing the string. Besides these articles and the target, archers are sometimes provided with a large case called an "ascham," fitted up with the necessary drawers and compartments for the reception of the bow, arrows, string, and other necessary accouterments. In archery-competition the total number and value of each person's hits are registered on a scoring-card. The shots are usually punctured on a card with a pin, as being preferable to pencil or ink-marks; and the mode of ascertaining the value of the hits, which is increased in proportion as they reach the center, will be seen by the following example:

Names.	Gold.	Red.	Blue.	Black.	White.	Total.	Value.
A...	. .	. . . . .	. . . . . .	. . . . . .	. . . . . .	35	119
				. . . . . .	. . . . . .		
					. . .		
B.........	.	. .	. . . . .	. . . . . .	. . . . . .	26	90
			. . .	.	. . . . .		

It appears by the card that A has 2 in the gold, 4 in the red, 6 in the inner white, 10 in the black, and 13 in the outer white, making a total of 35. The real value of these is ascertained by multiplying the hits in the gold by 9; in the red by 7; in the blue by 5; in the black by 3; and by leaving without alteration the number in the white or outer. By this process it will appear that A's numbers, according to the *value* of each circle, amount to 119, and B's to 90; hence A is the winner by 29. But A's *total* might have been less than B's, and still he might have been the winner, providing the shots had lain more towards the gold than B's. As an instance of the skill which long and careful practice may insure, Mr. Horace A. Ford, who has written an excellent work on archery, on one occasion, out of 144 shots, made 143 hits—765 score; on another, 144 shots, 137 hits—809 score; and on another, 75 shots, 75 hits—555 score.

ARCH-GAYE.—A lance used by the Gauls and Franks, which consisted of a sharp-pointed piece of iron attached to a light wooden handle. Also known as *Lance-gaye.*

ARCHIBALD WHEEL.—An iron-hubbed wheel used on the wagons and gun-carriages of the United States army. The wheel is noted for its strength, endurance, and independence of climatic changes. Fig. 1 represents a lateral section of the hub of this wheel, exposing the axle, bolts, and the method of construction. A is the axle; B, the back of the hub, which is also the axle-box; C, the front or loose flange; DD, the bolts through spokes and flanges; EE, the spokes; F, the brass cap; G, the axle-nut; a small screw at the outer extremity, is removed when oiling the axle. Fig. 2 shows the construction at the center and rim, and clearly exhibits the joints and the position of bolts. The size of the

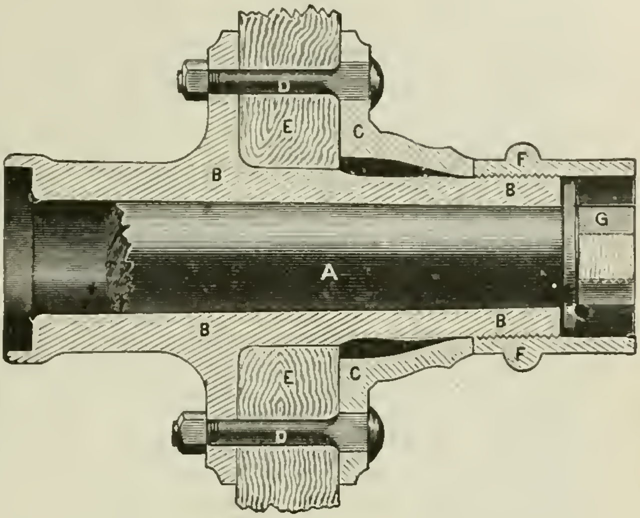


Fig. 1.

spokes in these wheels is, as a rule, the same as the diameter of the axle. In case of accident, the wheel may be readily repaired, its construction being so

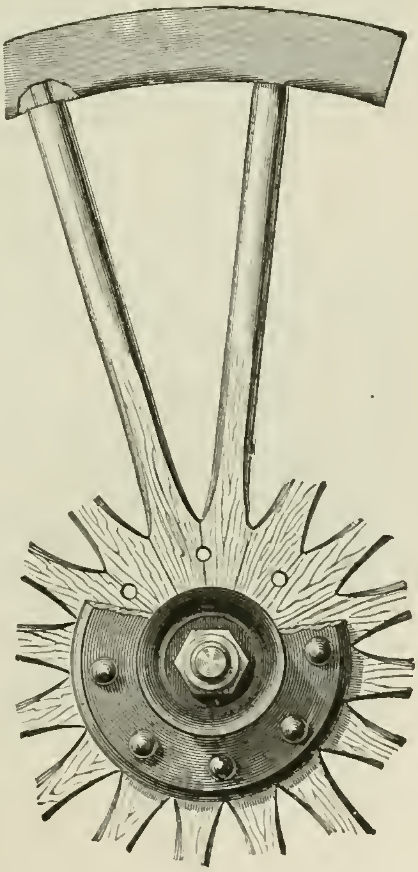


Fig. 2.

simple. Duplicate spokes, hubs or boxes, and axles should, if practicable, be kept on hand for the purposes of repair.

To replace a box and that portion of the hub at-

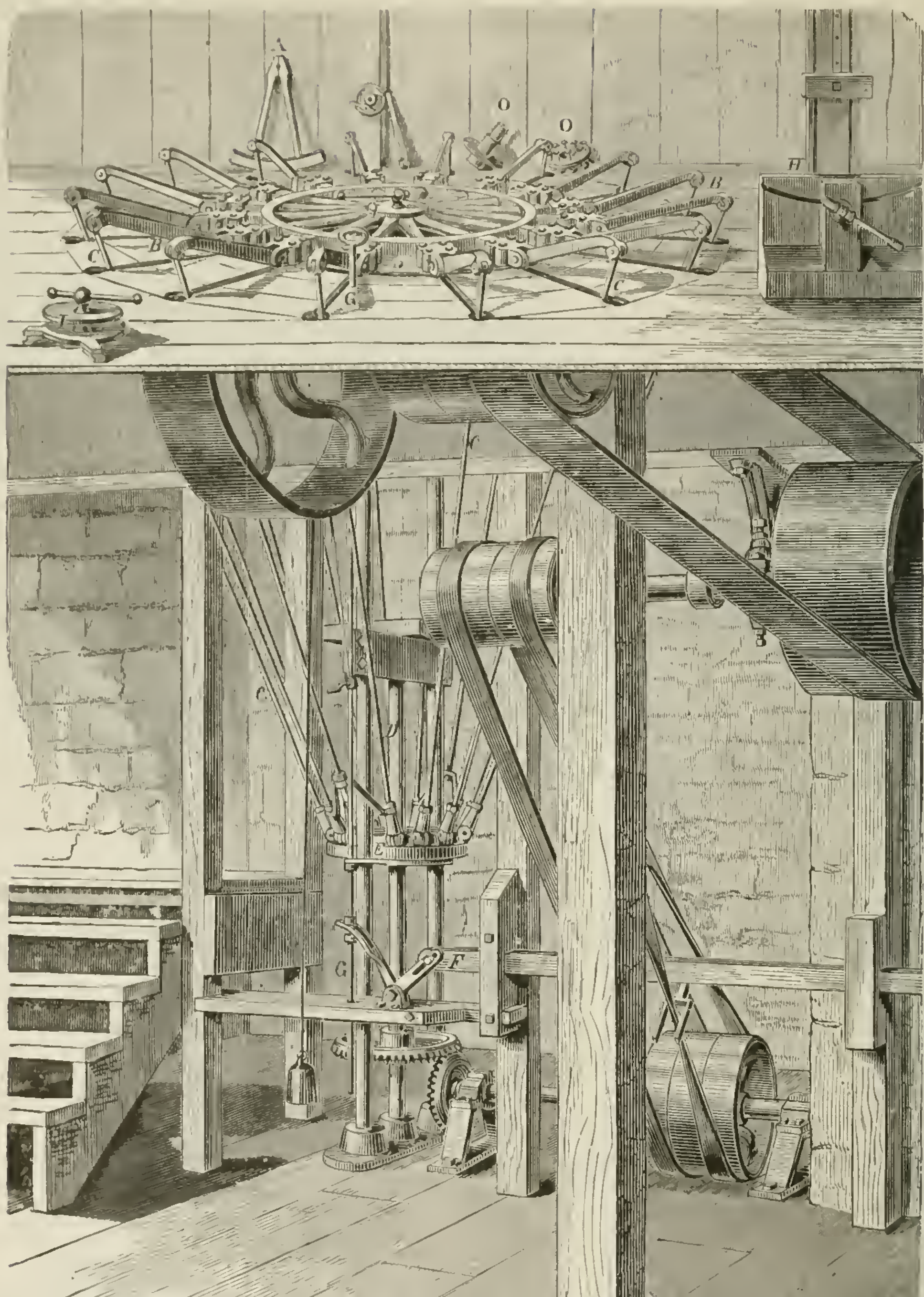


FIG. 3.

tached: Unscrew and remove the front hub-band, take off the hub-nuts, and the box will easily drive out. The new box is as easily put on again, after which screw on the front hub-band. The tire being on will hold the wood part so that it cannot move while the hub is being taken off. This hub or box is as firm and true on the wheel as was the first one. The change can be made by anybody, and in a few moments.

To repair a spoke: Take off the tire and felloe on the injured spoke (and in taking off this felloe it is not necessary on account of the peculiar dowel used to start off any other felloe), take out only the bolt that passes through the injured spoke, saw off this spoke as close to the hub as possible, and bore or dig out the spoke, drive in the duplicate spoke as far as possible, and arrange the tenon at the felloe so that the tire may press the spoke about ⅛ inch farther into the hub, and after the tire is on put in the hub-bolt.

The following is the approximate weight per set of each size and style of bed of axles fitted for Archibald Wheels, with beds long enough to weld up 4 feet 6 between axle-collars (shorter beds will weigh less, and longer beds more):

SIZE.	DRAWN.	PLATFORM.	SQUARE.
1½ inch.	65 lbs.	82 lbs.	90 lbs.
1⅝ "	80 "	95 "	105 "
1¾ "	95 "	115 "	125 "
1⅞ "	112 "	135 "	145 "
2 "	135 "	150 "	165 "
2⅛ "	155 "	185 "	190 "
2¼ "	175 "	205 "	210 "
2½ "	215 "	255 "	260 "
2¾ "	255 "	310 "	315 "
3 "	320 "	375 "	390 "

It is noticeable how much less these weigh than the same style of axles *with boxes* for wood-hub wheels.

The drawing on the opposite page shows the machine with which this wheel is manufactured, and a reference to same will assist in a perfect understanding of the structure and endurance of the wheel. The machine acts to force into close contact the flat surfaces of the spokes at their inner ends, and thus compact them, so that their faces form true circular planes, upon which the inner faces of the hub-flanges rest. It will be seen from the cut here printed, representing the machine, that it occupies two consecutive floors. A strong circular plate of cast-iron, about seven feet in diameter, having its upper surface faced off true, is placed horizontally level with the floor of the shop. Arranged at equal distances around its outer edge are a number of levers, B, equal to the number of spokes to be set in the wheel,—sixteen in this case,—having their fulcrums securely bolted to the plate. The long arms of the lever radiate from the plate about three feet all around; the short arms are formed into cams or rolling inclines, acting upon sliding pins of cast-iron, which move freely in a radial direction, in guides formed in the fulcrum-blocks. When the long arms of the levers are raised, the sliding pins are pressed outward by a spring, until they bear upon the cam-shaped short arms of the levers at the point nearest the fulcrum or center of motion of the lever. When the long arms of the levers are lowered, their sliding-pins are forced inward by the cams, and unite in pressing inward the wheel properly placed in their embrace. The levers are all actuated with rapidity, uniformity, and certainty, by means of wrought-iron rods, C, extending downward from the ends of the levers, converging to a vertical column, D, under the center of the plate, much as the braces of an umbrella extend downward from the ribs to the stick. A screw is cut upon the central column, D; and a nut, E, answering to the slide upon an umbrella-stick, raises or lowers all the levers at once with great facility and with any required power. Motion is given to the nut by means of beveled gears, and open and cross belts with fast and loose pulleys, so arranged that, at the upward and downward limits, the belts are thrown automatically upon the loose pulleys, and the motion of the nut and levers stopped. Any required motion, either up or down within the range of the screw, can be obtained with great delicacy and convenience by a shipper, F, actuated by a shipping-rod, G. The felloes and spokes, having been perfectly shaped and completely finished by machinery, are first put together by driving the spokes into the felloe or rim, one at a time; the felloe being held firmly by a vise, H, specially constructed to prevent splitting of the felloe or twisting of the spoke, so that an exact fit is obtained at this important point. The felloes with their spokes are then placed in the press, when the perfection of the fitting is shown by the perfect joint made by the spokes when they meet in the circle, to be curved and embraced by the hub, and by the coincidence of the half-holes in the contiguous sides of the spokes, A, which together form the holes for the eight bolts that are finally to hold the hub-plates together. Temporary hub-plates, I,—one above and one below,—with a powerful screw in their center, hold the ends of all the spokes truly in the plane of the circular plate while undergoing the pressure of the levers. The extent of this pressure is ascertained by marking carefully with a sharp pencil around the circumference of the upper temporary hub-plate after the spokes have been brought to a close, firm joint; and then the pressure is put on till the joint of the felloes closes up firmly. Another similar mark being made, upon removal of the temporary hub-plate, it is found that a space of a quarter of an inch is made between the two pencil-marks—a reduction in diameter of half an inch. Now, as the difference in circumference corresponding to a difference in diameter of half an inch is 1.5708 inches, this divided by 16 (the number of spokes) gives .098 of an inch, *or substantially one tenth of an inch, as the lateral compression of each spoke.* This is by no means the limit, but is regarded sufficient to secure the spokes against being loosened by shrinkage in any climate, and this pressure is what gives this wheel its enormous strength and durability. The hub, OO, is firmly bolted together while the wheel is in the press, and holds the spokes securely, the bolts fitting snugly in both spoke and hub. The felloes spring apart a little when taken from the press, but only a little; and the tire easily makes that all firm again.

So great is the facility with which this machine is operated, that one man with an assistant easily puts together a set per hour, including the time of adjusting machinery for the difference in diameter of the wheels.

The great point in this wheel, made in this manner, is the thorough compactness of the hub-ends of the spokes, though the other ends of the spokes and the joints in the felloes receive scarcely less benefit. By observing an old wheel it will be seen that the spokes are bedded into the felloes and hub. This is done by degrees, and is unavoidable in wheels made in the usual way. The only way to keep such a wheel together is to reset the tire, so as to take up the looseness caused by the slow crushing and grinding process. This is all prevented in the Archibald process of manufacture, by putting on a pressure at every joint of more than ten times the amount the wheel will ever be called upon to sustain in actual use, and at a time when the wheel is so held as to receive this pressure without possible injury to it. One tenth of this pressure from a tire would ruin the wheel, but the tire when properly put on will hold all this pressure and remain on tight until worn out. The hub holds all the pressure of the spokes within it independently of the tire. Wheels made by this method are perfectly round and true. The pressure distributed about the rim can be varied from zero to one hundred tons, if required. There are reasons why iron-hubbed wheels made in this manner should be far superior to wheels with wooden hubs. The spokes cannot crush into the hub, as they will do into wooden-hubs whether driven full size into a very large hub, as was the practice fifty years since, or, as at present, into a smaller hub, the spokes having tenons and shoulders. With wooden hubs the spokes are weakened just where they need the greatest strength; while in the iron-hubbed wheel the spokes are more than twice as large at the hub as a wooden-hub wheel of corresponding size. A wheel made on this plan will not shrink, and as the bases of the spokes are as firmly compressed against each other as it is possible for wood to be, and held by metallic flanges firmly bolted together, it is apparent that such a wheel possesses the advantage of the most perfect method of construction yet devised. See *Wheel*.

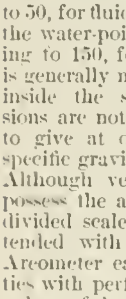
ARCHITONNERRE.—A machine made of copper, which threw iron bullets with great force and noise; it was used in ancient times, and was the invention of Archimedes.

ARCHITRAVE.—The master-beam, or chief supporter, in any part of a subterraneous fortification.

ARCO.—A metal composed of 70 parts of pure copper, 27 parts of zinc, and 3 parts of lead. It is used for the brass-work of small-arms.

AREA.—A term in mathematics meaning *quantity of surface*. The calculation of areas, or mensuration of surfaces, is one of the ultimate objects of geometry. The measuring unit is a square inch, a square foot, etc., according to the unit of length. As a figure is thus measured by finding an equivalent for its surface in *squares*, the process is sometimes called the *quadrature* of the figure. In a military sense, *area* is the superficial contents of any rampart or other work of a fortification.

AREOMETER.—An instrument, called also Hydrometer, which is allowed to float freely in liquids to determine their specific gravity or that of solid bodies. The delicacy of the instrument depends on the distance of the divisions on the scale, or on the thinness of the stem compared with the bulbs. An instrument possessing this advantage cannot be made to serve both for liquids heavier and lighter than water, for the stem would be of an inconvenient length; and it is usual to construct two Areometers—one marked with the water-point at the top and the scale descending to 50, for fluids heavier than water; and the other with the water-point at the bottom and the scale ascending to 150, for fluids lighter than water. The scale is generally marked on a slip of paper, which is fixed inside the stem. On some Areometers the divisions are not at equal distances, but are so drawn as to give at once, without table or calculation, the specific gravity of the fluid in which they are placed. Although very desirable, in practice they do not possess the accuracy of the Areometer with equally-divided scales, because the graduation of them is attended with considerable difficulty. No form of Areometer can be made to determine specific gravities with perfect accuracy, and such instruments are only useful where a ready and good approximation is all that is needed. They are, in consequence, employed chiefly to ascertain the specific gravity of the various liquors and solutions which occur in the arts and manufactures, and very frequently they are graduated with reference to special liquids, as spirits, wine, milk, brine, etc. The alcoholometer or Lydrometer of Sikes is an instrument of this latter description, and is in general use in the excise for estimating the strength of spirits. The peculiar feature of Areometers with weights is that, instead of a scale, they have only one mark on the stem, to which the Areometer is in all cases sunk. One of the best-known instruments of this kind is the Areometer of Nicholson. It consists of a brass tube, BC, about 1 inch in diameter, closed above and below by conical ends, to the upper of which a wire is fixed, carrying on the top of it a cup, A, capable of containing the weights; and to the lower a hook is attached, from which hangs the cup, D. The lower part of the cup, D, is also provided with a hook, and the whole instrument is kept vertical, partly by the weight of the cup and partly by the weight of the ball, E, suspended from it. On the wire, a notch, W, is made, to serve as the mark or fixed point to which the Areometer is sunk. The specific gravities of liquids are determined by Nicholson's Areometer in the following way: The weight of the Areometer itself is first ascertained—let it be in a given case 2000 grains; it is then put into water at the temperature of 60° F., and weights (say 500 grains) put in, till it is sunk to W. It is now removed to the liquid under examination; and if the weight required to sink the instrument now to the standard-point be only 100 grains, we have the specific gravity of the liquid equal to $\frac{2100}{2500}$, or $\frac{21}{25}$. In both fluids the same volume has been displaced, and that is in each case equal to the weight of the Areometer; but the weight of the Areometer in the second case was 2000 + 100, and in the former 2000 + 500; hence the above result. Nicholson's Areometer is seldom used for finding the specific gravity of fluids; its use is almost entirely restricted to ascertaining that of small solid substances. The following example will show how this is done: If in the cup of the Areometer already mentioned, when placed in water, the solid be put, and only 440 grains be then necessary to bring the instrument to W, 60 grains is manifestly the weight of the solid, because 500 grains were needed without it to do the same thing. The solid is next placed in the lower cup, D, and if 460 grains are now needed to sink to the standard-point, the solid has thus lost 20 grains of its weight by being immersed in the water. According to the principles of Archimedes, these 20 grains are also the weight of a volume of water equal to that of the solid; so the specific gravity of the solid is $\frac{60}{20}$, or 3. By reversing the cup, D, which is furnished with perforations, to allow free passage to the air, and attaching the weight, E, to the handle of it, the specific gravity of substances lighter than water may also be determined by this instrument. The other forms of weight-areometers are those of Fahrenheit, Tralles, and Charles. See *Hydrometer* and *Specific Gravity*.



AREOSCOPE.—An instrument used for analyzing the air of barracks, hospitals, etc. It is principally employed by the English Medical Corps.

ARES.—The god of war in Greek mythology, and corresponding to the Roman Mars.

ARGENT.—The French word for silver; always used in English Heraldry to signify that metal. In engraving shields it is left white.

ARGOULET.—An ancient dragoon. Also an inferior sort of musket made at Liege for trading with the negroes.

ARIES.—The battering-ram, so called because the metallic head was sometimes fashioned like the head of a ram. As a means of battering walls it is said to have been invented by Artemanes of Calzomene, a Greek architect, about 441 B.C. It is described by Josephus, who states that it was sometimes supported on the shoulders of men who advanced on a run; at other times it was slung from a frame, and operated by ropes. Philip of Macedon is said to have been the first to place the frame on wheels, at the siege of Byzantium. Plutarch informs us that Mark Antony, in the Parthian war, made use of an aries 80 feet long. Vitruvius says they were sometimes 106 to 120 feet in length.

ARM.—1. An instrument of warfare; a weapon of offence or defence. 2. Any particular description or class of troops. The Artillery, the Cavalry, the Infantry, and the Engineers are each an arm of the service. The word used figuratively denotes power. 3. That portion of an axletree about which the wheel revolves. See *Axletree-arm*.

ARMAMENT.—All arrangements made for the defence, with musketry and artillery, belong to what is termed the *armament*. The armament with musketry is complete when the banquette and the interior and superior slopes are properly arranged to enable the soldier to deliver his fire with effect, and to mount on the parapet to meet the enemy with the bayonet. For this last purpose stout pickets may be driven into the interior slope, about midway from the bottom and three feet apart, or a narrow plank may be laid along this slope. The armament with artillery is, in like manner, complete when suitable means are taken to allow the guns to fire over the parapet or through openings made in it, and when all the required accessories are provided for the service of the guns. The armament with artillery is a subject of great importance, because it is not equally adapted to all classes of works. Experience has demonstrated that the most efficient way of employing artillery is in protecting the collateral salients by a well-directed flank- and cross-fire which shall not leave untouched a single foot of ground within its range over which the enemy must approach. It has, moreover, shown that a work with a weak profile affords but little security to artillery within it; for artillery cannot defend itself, and such a work can be too easily carried by assault to offer any hope of keeping the enemy at a distance long enough to allow the artillery to produce its full effect. The proper positions for artillery are on the flanks and salients of a work, because from these points the salients are best protected and the approaches best swept; and the guns should be collected at these points in batteries of several pieces, for experience has shown that it is only by opening a heavy, well-sustained fire on the enemy's columns that an efficient check can be given to them. If only a few files are taken off, or the shot passes over the men, it rather inspires the enemy with confidence in his safety, and with contempt for the defences.

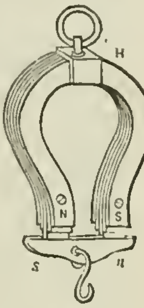
When, in the defence of a work, from the indications without there is no longer any doubt respecting the real point of attack selected, all the disposable artillery will be brought forward and placed in barbette, in the best positions on this point and the collateral works for sweeping the ground over which the trenches must be pushed. In the mean time embrasures, platforms, and traverses should be prepared on the most suitable positions, to place the artillery under shelter from the enfilading batteries so soon as they are ready to open fire. Every disposable gun, except the reserve pieces, should, both at this time and whilst the besiegers' batteries are still incomplete, be placed in positions to bear upon the points occupied by them, with mortars of long range placed wherever they will be well masked and can throw their shells with the most effect against these points. The traverses, to cover from enfilade views, should be shot-proof gabionades, and be placed so far apart only as to allow the least room for two guns between them. The terre-pleins of the barbettes should be cut down and their parapets somewhat raised, to admit of embrasures for the guns along them. The fire of the defences should be concentrated on a few of the principal batteries rather than scattered over all, because, by delaying the progress of these, the others, if the besiegers act prudently, will not open their fire until all are ready.

ARMAMENTARY.—A term sometimes employed to denote an armory, magazine, or arsenal.

ARMA SHOT.—An expression meaning to roll rope-yarns about a cross-bar shot in order to facilitate ramming it home, and also to prevent the ends catching any accidental inequalities in the bore.

ARMATURA.—In ancient military history, the fixed and established military exercises of the Romans. Under this heading is understood the throwing of the spear, javelin, shooting with bows and arrows, etc. Armatura was also an appellation given to the soldiers who were light-armed; as, also, a name given to the soldiers in the Emperor's retinue.

ARMATURE.—1. Armor worn or used for the protection and defence of the body. 2. The term armature is applied to the pieces of soft iron that are placed at the extremities or poles of magnets to preserve their magnetic power. When magnets are allowed to remain any length of time without such appendages, in consequence of the disturbing influence of terrestrial magnetism they lose considerably in strength; but when they are provided with them their magnetism is kept in a state of constant activity, and thereby shielded from this disturbance. The reason of this is found in two facts well known in the science of magnetism; viz., that when a piece of soft iron is brought into contact with the extremity of a magnet it is itself induced to become magnetic, and that the unlike poles of two different magnets powerfully attract each other. Referring to the figure, the north pole, N, of the horseshoe-magnet, NHS, acting on the armature, *sn*, induces it to become a magnet, having its south pole, *s*, next to N, and its north pole, *n*, at the opposite extremity. The pole, S, by virtue of its magnetic affinity powerfully attracts the north pole, *n*, thus formed, and adds its own inducing influence to heighten the magnetic condition previously induced in the armature by the pole, N. The armature, from the combined action of both poles of the horseshoe-magnet, is thus converted into a powerful magnet, with its poles lying in an opposite direction to that of the primary poles. The original magnet is, in consequence, brought into contact with one of its own making, the exact counterpart of itself—a condition highly favorable to the maintenance of its strength. It is due to the same mutual attractions that a much larger weight can be suspended from the armature thus placed than what the single poles can together sustain. Bar-magnets may be armed in the same way by laying them at some distance parallel to each other, with their unlike poles towards the same parts, and then connecting their extremities by two pieces of soft iron. When a magnet, such as a compass-needle, is free to take up the position required by the magnetism of the earth, the earth itself plays the part of an armature.



ARM-CHEST.—A portable locker for holding arms, and affording a ready supply of pistols, muskets, or other weapons. Also used in the military service for the transportation of rifles, revolvers, etc.

ARME BLANCHE.—Literally, white arm. Arms used in hand-to-hand conflicts, such as swords, bayonets, foils, etc.

ARME COURTOISE.—An arm used in tilts or tournaments during the Middle Ages. It was a kind of sword with a ring or knot placed at the tip of the blade to prevent it causing a dangerous wound.

ARMED RECONNOISSANCE. — Reconnoissances made in the neighborhood of an enemy require to be done under the protection of a proper detachment, the strength and composition of which will depend on the object to be attained. If the object be to gain secretly a knowledge of the enemy's whereabouts and strength, then a detachment of light cavalry, conducted by a trusty guide through circuitous by-ways, and moving with celerity, but with proper precautions against falling into an ambush or having its retreat cut off, is usually resorted to. The details for this will be found under the head *Patrols*. When an enemy's position is to be reconnoitred with a view to force him to show his hand, by causing him to call out all his troops, then a large detachment of all arms, adequate to the task of pressing the enemy vigorously, and also of withdrawing with safety when pressed in turn, must be thrown forward. Under the shelter of either of these forces, the officer charged with the reconnoissance takes the best moment and best point of view for carefully ascertaining the dispositions made by the enemy. A good time will be at early dawn, when troops, in most services, are all made to stand to their arms. The points which the officer must exhibit most attention in finding out are those occupied by the batteries, and all those in any way intrenched. See *Field-service* and *Reconnoissance*.

ARMED WHIP.—A kind of hand-flail or knout, with three, four, or six chains. This weapon is frequently called *Scorpion*.

ARMES DE JET.—Missive weapons; offensive arms or instruments which act by propulsion, whether by the force of powder, steam, wind, or mechanism.

ARMET.—A helmet or head-piece consisting of a globular iron cap, which spreads out with a large hollowed projection over the back of the neck, and in front has a piece formed like part of a bowl, so as to cover the mouth and chin.

ARMGAUNT.—That which is worn out by military service; as, an armgaunt steed, etc.

ARM-GUARDS.—Hollow plates of metal to be buckled over the mail, and adjusted to the outer surface of the upper arm and to the front of the lower arm, which bore the appropriate name of *arm-guards* or gardes-bras.

ARMIGER.—Formerly an armor-bearer, as of a knight; an esquire who bore his shield and rendered other services. In later use, one next in degree to a knight, and entitled to a coat of arms.

ARMILAUSA.—A military uniform coat worn by the Romans over their armor.

ARMILUDIA.—A name given by the Romans to the exercises of arms, and also applied to the day on which these exercises took place.

ARMILUSTRIUM.—The name given by the Romans to a military festival which took place on the 19th of October annually. After review, the soldiers offered up sacrifices for the success of the Roman arms.

ARMISTICE.—A cessation of active hostilities for a period agreed upon between belligerents. It must be agreed upon in writing, and duly ratified by the highest authorities of the contending parties. If an armistice be declared, without conditions, it extends no further than to require a total cessation of hostilities along the front of both belligerents. If conditions be agreed upon, they should be clearly expressed, and must be rigidly adhered to by both parties. If either party violates any express condition, the armistice may be declared null and void by the other. An armistice may be general, and valid for all points and lines of the belligerents; or special, that is, referring to certain troops or certain localities only. An armistice may be concluded for a definite time; or for an indefinite time, during which either belligerent may resume hostilities on giving the notice agreed upon to the other. The motives which induce the one or the other belligerent to conclude an armistice, whether it be expected to be preliminary to a treaty of peace, or to prepare during the armistice for a more vigorous prosecution of the war, does in no way affect the character of the armistice itself. An armistice is binding upon the belligerents from the day of the agreed commencement; but the officers of the armies are responsible from the day only when they receive official information of its existence. Commanding Officers have the right to conclude armistices binding on the district over which their command extends, but such armistice is subject to the ratification of the superior authority, and ceases so soon as it is made known to the enemy that the armistice is not ratified, even if a certain time for the elapsing between giving notice of cessation and the resumption of hostilities should have been stipulated for. It is incumbent upon the contracting parties of an armistice to stipulate what intercourse of persons or traffic between the inhabitants of the territories occupied by the hostile armies shall be allowed, if any. If nothing is stipulated, the intercourse remains suspended, as during actual hostilities. An armistice is not a partial or a temporary peace; it is only the suspension of military operations to the extent agreed upon by the parties. When an armistice is concluded between a fortified place and the army besieging it, it is agreed by all the authorities on this subject that the besieger must cease all extension, perfection, or advance of his attacking works, as much so as from attacks by main force. But as there is a difference of opinion among martial jurists whether the besieged have the right to repair breaches or to erect new works of defence within the place during an armistice, this point should be determined by express agreement between the parties. So soon as a capitulation is signed, the capitulator has no right to demolish, destroy, or injure the works, arms, stores, or ammunition in his possession, during the time which elapses between the signing and the execution of the capitulation, unless otherwise stipulated in the same. When an armistice is clearly broken by one of the parties, the other party is released from all obligation to observe it. Prisoners taken in the act of breaking an armistice must be treated as prisoners of war, the officer alone being responsible who gives the order for such a violation of an armistice. The highest authority of the belligerent aggrieved may demand redress for the infraction of an armistice. Belligerents sometimes conclude an armistice while their plenipotentiaries are met to discuss the conditions of a treaty of peace; but plenipotentiaries may meet without a preliminary armistice; in the latter case, the war is carried on without any abatement. See *Capitulation* and *Truce*.

ARMLET.—A protecting sleeve of leather or metal worn on the forearm, and used as a shield for the arm or as a covering for that portion of the coat-sleeve.

ARMOR—ARMOUR.—A general name for the apparatus for personal defence, as contradistinguished from arms or weapons of offence. Little of it is worn by soldiers at the present day, seeing that hand-to-hand conflicts, in which it is especially serviceable, are rather exceptional in modern warfare. It was before the invention of gunpowder that armor—often called in England by the name of *harness*—was especially used. All the ancient nations who occupy a place in history were accustomed to adopt one or other of the defensive clothing or implements which collectively come under the denomination of armor. Leather armor was sometimes worn; but brass, iron, and other metals were preferred. Some of the more luxurious leaders had much silver and gold in their armor. In the Bible, shields, helmets, breastplates, and greaves are mentioned among the articles of armor borne or worn by the Israelites and their opponents. The classical writers—Homer, Xenophon, Herodotus, Livy, Tacitus, Varro, etc.—supply abundant evidence of the use of armor among the nations concerning whom they wrote. It is believed that the early Britons bore little or no other armor than shields. The Anglo-Saxons were more fully provided. At different times before the Norman Conquest they appear to have had four-cornered helmets; loricæ made of leather; scale-armor; leathern helmets; wooden shields covered with leather; sheep-skin shields; conical caps or helmets of metal; pectorals or neck-guards; breast-guards of undressed hide; flat-ringed armor; byrnes or tunics of overlapping pieces of leather; close-fitting cuirasses of leather, and sometimes of strong linen; leg-guards of twisted woollen cloth; shields of various sizes, from half a yard to a yard and a half in length; and casques having more or less resemblance to the ancient helmets. When the Danes were in Britain they had at first no other armor than leathern neck-pieces, which descended some way over the shoulders and chest; and greaves or shin-pieces for the legs. In the time of Canute or Knute, however, they adopted a kind of armor which Sir Samuel Meyrick supposes them to have borrowed from the Norsemen or Norwegians. It comprised a tunic, with a hood and long sleeves; pantaloons which covered feet as well as legs; and sugar-loaf-shaped helmets or skull-caps, with attached pieces which hid nearly the whole face except the eyes. All these were probably made of leather; but most of the surfaces were strengthened by macles or mascles, a perforated network of steel.

With William the Conqueror came in the kinds of armor which were at that time prevalent among the knights and soldiers of the Continent of Europe, and which became afterwards more or less combined with the armor previously known in England. William himself occasionally wore a hauberk of ring-armor. This kind of armor was much worn during his reign, the rings being usually attached to a foundation of leather. One curious variety of ring-armor, called the haubergeon, had the tunic and breeches all in one piece. The helmets were generally conical, with a nasal or nose-guard descending from the front. A distinct ring-armor, called *hose*, was often worn on the legs. The shield was generally kite-shaped, unlike the oval shield carried by the Anglo-Saxons. Gradual changes in these various portions of armor were made between the reigns of William, Rufus and John. Under Henry III., we find stitched and padded hauberks and chaussés, called "ouvrages de pourpointerie"; suits of ring-armor; greaves or shin-pieces of steel; poleyns or knee-guards; vambraces or arm-guards; jacks, jaques, or jackets, made of leather,

Suit of Armor,
presented by the Emperor Maximilian to Henry VIII.

and worn over the ring-armor; interlaced ring-armor of oriental invention, not requiring to be stitched to any garment or foundation; helmets, visors, and skull-caps of various forms; and chanfrons, or armor for the head and face of horses. During Edward III.'s reign iron plate-armor was much used by troopers, in the various forms of helmet, breastplate, gauntlet, and greaves. In the fourteenth century chain-mail fell into disuse, and was succeeded by plate-armor; this last-named kind became more and more complicated, and reached its greatest pitch of elaboration in the reign of Richard III. During the times of Henry VII. and VIII. the armor was sometimes fluted, often elaborately engraved, and even damascened or inlaid with gold. Under James I. the knightly ideas of the feudal times gave way, and the use of armor declined; a knight armed *cap-à-pie* was a rarity. Charles I. tried to revive its use, but he had few followers; and the days of Cromwell may be regarded as the last in which armor was worn to any considerable extent by the regular soldiers. Helmets and cuirasses are still worn by the three regiments of Household Cavalry (Life-Guards and Horse-Guards), but more for show than for service.

ARMOR-BEARER.—One who carries the armor of another; an Armiger; an Esquire.

ARMORED DEFENSES.—The first time that a rifled gun was fired at armor for land-works was in 1860, when an 80-pdr. Armstrong gun fired wrought-iron flat-headed shot, and a 40-pdr. fired cast-iron shot, at two iron embrasures (8 inches and 10 inches thick) fixed in a masonry-work at Shoeburyness. This trial brought out the advantages arising from the use of iron for strengthening works, and the disadvantage of having splayed sides in an iron embrasure. From that time experiments against armor followed each other rapidly. In 1861 comparative trials were made between wrought-iron armor-plates backed with rigid materials, such as cast-iron and granite, and similar plates backed with timber, cork, India-rubber, layers of wire, and other substances. From these it was gathered that while the hard materials improved the resisting power of the armor, they led to its being more injured by cracking and to the giving way of fastenings. Other trials were made with wrought-iron plates inclined to the horizon at various angles, from which it was concluded that a mass of armor placed upright will offer as much resistance as the same mass disposed at any inclination so as to cover the same vertical area. Even *wool* was experimented upon as to its power of resisting cannon-shot. Next, some shields, 6 inches and 10 inches thick, composed mainly of boiler-plates ⅝ inch thick, riveted and screwed together, gave very indifferent results, and two other heavier casemate-shields, of very opposite construction, made of massive slabs of rolled iron, laid one in front of the other, and crossing at right angles, with lead between them, were tried, in 1862–3, with good results. In the Warrior target, composed of 4½ inches of rolled-iron plates on 17 inches of wood, backed by a thin iron skin, we see the advantage of timber backing, the weakness of joints in armor, and the disadvantage of joining armor-plates to each other by means of tongues and grooves on their edges. In other of these ship's targets the question of providing a compound backing of wood and iron instead of wood alone is practically solved in favor of the former, and the disadvantage of doing away with all wood in the backing is also proved. Up to 1863, the heaviest gun used in experiment was a 10½-inch rifled gun, throwing a cylindrical shot of about 300 lbs., with a muzzle-velocity of about 1320 f.-s. There were also a 7-inch Whitworth (130-pdr.) and a large 13-inch smooth-bore Horsfall gun. But shortly afterwards a 23-ton gun of 13.3 inches' caliber, capable of piercing a ship's side stronger than that of the Warrior at two miles' range with a shot of 600 lbs., called for a corresponding advance in the strength of armored structures. Consequently H.M.S. Hercules was protected with 9-inch armor at her water-line; and a target representing her at this part, with a very massive backing of teak and iron stringers, ribs, and skin, afforded effective resistance to the gun above referred to at 700 yards range, and would have done so at much shorter ranges. This trial showed the advantage of giving depth or thickness to shot-resisting structures. A method of holding on armor-plates by continuous irons turned over their edges instead of by bolts was also tried, but there were objections to it.

Turning again more particularly to the protection of land-works, the following experience was gained about this time—that is, in 1865. Two complete masonry casemates, with ports in iron shields, were built at Shoeburyness. The masonry was 14 feet thick, consisting, generally, of a face of 6 to 8 feet of stone, with brick-work behind it, and the side walls and vaulting of the casemates were of brick. The shield of one was a compound structure 12 feet long, 8 feet high, and, altogether, 21 inches thick (including 7 inches of wood); that of the other was made out of a solid rolled-iron plate 7 feet high, 6 feet wide, and 13½ inches thick. After the mounting, working, and firing of a 23-ton and a 12-ton gun in the casemates, as well as on the roofs, had proved the work to be suitable in arrangement for such guns, the front of the work was attacked by a battery of 7-inch, 8-inch, 9.22-inch, and 10-inch guns, at ranges of 600 and 1000 yards, firing steel and cast-iron shot, some with hemispherical and some with elliptical heads. The general result of this trial was that after 33 hits the work began to become untenable, after 54 hits its fire would have been virtually silenced, and after 86 hits, of which 22 were on iron, the masonry front was destroyed, but the shields still afforded a fair amount of protection. The aggregate of all the blows delivered came to 200,000 foot-tons, of which 52,000 were on iron. Among many other trials that took place about this time were those which brought out the excellent qualities of chilled cast-iron for battering projectiles, as proposed by Captain (now Sir W.) Palliser, and also the advantages of the pointed (ogival) over the blunt (hemispherical) head. For these experiments iron armor, placed both directly and obliquely to the line of fire, was used; chilled iron, in consequence of these results, almost entirely superseded steel for battering projectiles, for a time at 'east. Next in order came a series of trials of plates of steel, and of steel and iron combined; some were of thin layers of steel and iron welded together, others of sandwiches of steel between rolled iron, others of faces of steel welded to iron, and others of steel and iron in reverse order to this; but none of these competed successfully with a simple soft rolled-iron plate in resisting chilled-iron shot. Some plates made entirely of steel were tried about this time, as they had been also years before, but none of them stood at all well. The difficulty of treating steel in large masses, and especially of welding these masses of steel and iron together, had evidently not been mastered up to this time. In consequence of the growing powers of battering-ordnance, it now became evident that land-works would require walls of considerable thicknesses of armor; but there were two main reasons why very thick armor-plates should not be used in them. In the first place, the manufacture of a very thick plate is not so complete as that of one of moderate thickness, or at least to make it as complete would involve an enormous increase of cost in plant and manufacture; and next, the thicker the plates the deeper the joints must be, and therefore the more points of undue weakness will the armor present. It therefore became important to see whether the required protection could not be gained without the use of very thick plates. Against doing this was the prevailing opinion, based chiefly on theoretical considerations, that a single plate of given thickness would offer something like twice the combined resistance of two plates each of half that thickness, or about three times the resistance of three plates, making up the same total thickness, and so on. This view was entirely disputed by those who had to deal with these questions officially.

In 1871 two targets representing portions of the walls of ships' turrets were tried at Shoeburyness. The one was protected by single 14-inch plates, the other by two thicknesses of armor, 8-inch and 6-inch respectively, with 9 inches of timber between them. In other respects the targets were similar. After receiving the same amount of battering the armor of both was taken off, and the effect upon the inner skin of the two-plate target was unmistakably less than that on the single-plate structure. It may also be mentioned that, more recently still, a structure composed of three thicknesses of 6½ inches of iron proved rather superior to a solid 16½-inch plate in stopping the 818-lb. shot of the service 38-ton gun, striking with a velocity of about 1415 f.-s. To settle the best proportions, quantity, and best nature of material to be interposed between armor-plates, a series of careful experiments was set on foot, and the result was that a uniform spacing of about 5 inches (to be slightly modified under certain circumstances) between the different plates in all structures was decided upon; and also, although an iron concrete, made by working up together cast-iron borings, asphalt, bitumen, and pitch, gave the best result, mainly on account of its great weight, yet brick-work in asphalt, Portland-cement concrete, and hard wood proved so satisfactory that these materials have been adopted, as circumstances required, in all armored walls. It may be well to mention here a very remarkable result that was obtained in the course of the early trials with plate-upon-plate structures. When void spaces were left between the plates of these structures it was found that the heads of the Palliser shells collapsed completely under the work they had to do in penetrating them, and, naturally, the effect produced upon the target was thereby very much reduced. In one case a chilled shot from the 38-ton gun, which was capable of piercing 19½ inches of armor, was found sticking in a finely divided state against a 10-inch plate after having passed through only a 4-inch plate a few feet in front of it; and on another occasion, a 4½-inch plate, set up 18 inches in front of a masonry wall, with a void space between them, so far reduced the effect of a chilled cast-iron projectile from the 38-ton gun, at 50 yards, that it broke up on first striking the granite, and was afterwards dug out in pieces at a depth of only about 3 feet 6 inches from the original front of the masonry. Repeated and well-pronounced instances of this utter destruction of chilled projectiles from this cause have been gained and carefully investigated, with a view to turning the principle to some account in defence-works; but partly on account of certain difficulties of detail, and mainly on account of the action not being produced on steel projectiles, the idea of using void spacing in practice has been nearly given up. The next trials on a large scale were those of 1868, at Shoeburyness. In these, a casemate having a front of 22 feet by 14 feet, representing a portion of the iron fort which was then in course of construction for the position behind Plymouth breakwater fort, stood 37 rounds from the 12-inch gun of 25 tons, charge 76 lbs. pellet-powder, the 10-inch gun of 18 tons, charge 60 lbs. R. L. G., and the 15-inch Rodman gun of 19 tons, charge 100 lbs. American (equivalent to 83¼ lbs. English) powder, at 200 yards' range; and although it was of course considerably damaged by this fire, it was, at the end of it, pronounced to be defensible. This trial led to some important additions being made to the front wall of the fort itself as it went on. The roof also of this casemate was tested by the fire of 13-inch mortars at 1000 yards, but they proved quite powerless against it. Only a few shells, however, struck it out of nearly 300 rounds. Adjoining this casemate was another embodying several kinds of cellular construction in its iron front, with the object of comparing the resistance of moderately thick solid plates with that of thinner front plates supported by cellular compound backing; but in no instance did the latter construction prove itself superior to the other. This result was borne out by the trial of another shield in 1868. The support given to armor by massive piers of masonry and concrete, cased in thick boiler-plate, proved very satisfactory.

It may be well here to notice briefly the matter of holding on armor-plates, on which so much of course depends, and we may begin by saying that of the innumerable contrivances for this object nothing has been found equal to that of a simple screwed wrought-iron bolt fitted with nuts. The steps by which the present pattern of armor-bolt for fortifications has been arrived at may be thus described: At first a bolt with a deep V-shaped screw-thread was used, but in the early stages of the trials a shallow round-cut thread was substituted for this with great advantage. Also a gradual and slight cone was adopted in lieu of the abrupt and spreading cone used at first in the heads of these bolts. Next, Sir W. Palliser's valuable suggestion that part of the shank or stem of an armor-bolt should be reduced to the lesser diameter of the thread led to an immense improvement, and this has been since extended to the whole length of the stem, leaving the thread a plus or raised thread, thus facilitating the extension of the material of the bolt throughout its whole length instead of locally in short lengths. Then Captain English proposed, first, the rounding of the bearing surface of a common hexagon nut, and afterward the use of a spherical nut seated in a cup-shaped hole in the armor or in a special cupped washer; with these improvements and that of the enlargement of the holes through which the bolt has to pass (all of which have for their object the relief of the bolt from cross-strains, and the insertion of a due proportion of elastic material to be squeezed when the bolt is put under tension) all difficulties with bolts have disappeared, and instead of their being sources of weakness they really, in most cases, give assistance to the armor. The special washers are of the following make: First, a circular washer is made by coiling and welding a bar 1¼ inch by ½ inch, and this is cupped to suit the spherical nut of the bolt. To strengthen this part an outer coil of unwelded bar of about the same section is screwed around it; as this outer coil has to expand after the inner coil may have given way, and as in doing so it would naturally unwind itself and open out, this tendency to separation has been met by making the thread by which this outer coil is screwed on to the inner of quicker pitch than that of its own coils, and thus as it unwinds it actually becomes more and more tightly squeezed together.

All other trials of this period may now be passed over until we come to that of the casemate-shield set up at Shoeburyness in 1870, which embodied all the experience gained from the previous twelve years of experiment. The guns used were the 12-inch of 25 tons, the 10-inch of 18 tons, the 9-inch Whitworth gun of 14½ tons, and the 15-inch Rodman of 19 tons, at 200 yards. Some rounds were fired obliquely, but most of them were fired direct at the face of the shield. The shield, which presented a front of 12 feet by 8 feet, received 17 blows, equivalent to 90,000 foot-tons, and, except in one or two matters of detail which were susceptible of easy improvement, it stood the trial remarkably well, and proved that it possessed a great margin of strength for these and even more powerful guns. In 1872 a plate-upon-plate target, representing 17 inches of armor altogether, stopped a Palliser shot fired direct at it from the 35-ton 12-inch gun with 110 lbs. of P. powder; and a similar target with 13 inches of armor stopped a shot from the same gun, striking it at an angle of 60° with its face. In 1861 the cupola of the Trusty was tried off Sheerness. It was in the form of a truncated cone, covered with 4½ inches of armor, and resisted fairly well the guns of those days. The cupola was not damaged in its machinery throughout the trial. Next, in 1866, one of the turrets of the Royal Sovereign, carrying armor in thickness 5½ to 10 inches, was tried at Spithead with the 12½-ton guns of H.M.S. Bellerophon. The turret was a good deal injured, but the turning machinery remained in working order. In 1872 the turret of the Glatton was tried at Portland with the fire of a 12-inch 25-ton gun of H.M.S. Hotspur, at 200 yards' range. The armor was 14 inches thick, and it received two Palliser shots, fired with 85-lb. charges, one of which grazed first on the glacis. There was some damage done inside the turret, but the goat, rabbit, and fowl which had been placed inside were unharmed, and the turret turned freely after the trial. In 1870–1–2 some lengthened trials were made with shot and shell impinging upon ship's decks, which gave some decided results, namely, that a 13-inch mortar shell at 4200 yards' range would go easily through a strong ship's deck covered with 1½-inch plating and 4½-inch wood planking, and that at 2800 yards it would go through it if covered with 1-inch plating; that 9-inch *live shell* from the 12-ton gun striking at an angle of 8° is too much for a similar deck covered with 1½-inch plating at short range, but the same deck will just turn a 9-inch *shot* at the same angle. Also, that a strong deck covered with 3-inch plating and 4 inches of oak was only just proof against 10-inch shells fired with battering charges from the 18-ton gun and striking at an angle of 10°. The rule that roughly held good a few years back, that battering guns could not at the shortest range do more than pierce iron armor-plates equal in thickness to their own caliber, has been quite upset in the last year or two by practice from the new long guns, with bores of 23 and more calibers in length. Thus a 6-inch gun of less than 4 tons' weight, and an 8-inch gun of less than 12 tons, have pierced within an inch of double their caliber in thickness of solid iron plate; and calculations tend to show that the long B. L. guns of 9.2-inch of 18 tons, the 10.4-inch of 26 tons, and the 12-inch of 43 tons' weight achieve fully as much as this.

Speaking generally, the service-guns were always capable of doing somewhat more than is indicated by the old rule above mentioned, and if with the improved powders of the present day their charges can with safety be increased to the extent which we believe has been proposed for them—as, for instance, 90 lbs. P^2 for the 10-inch 18-ton gun, 110 lbs. P^2 for the 11-inch 25-ton gun, and 160 lbs. P^2 for the 12½-inch 38-ton gun—then these guns will be nearly if not quite able to pierce at short range a thickness of solid iron equal to 1½ times their caliber. While upon this subject, we may say that no great advance has been made in late years toward determining a *law* for the resistance of armor, nor do we think that for practical purposes—whatever may be the case from a scientific point of view—much good will come of inquiry in this direction. The conditions and effects are altogether too variable and uncertain for the construction of mathematical formulæ. For instance, in recent practice, under apparently similar conditions of projectiles and plates, there has been an unaccounted-for variation of effect of something like 5 per cent plus or minus. But we can, by building upon results obtained with one gun, say within a little what another gun will do, and so construct tables of penetrations for all velocities, or, in other words, for all ranges. Thus, with the average service conditions of weight and length of battering projectiles, a shell of good quality with a velocity between 1050 to 1150 f.-s. will pierce solid iron equal in thickness to its own caliber; with a velocity between 1500 and 1650 it will pierce iron of a thickness equal to one and a half times its caliber; and with a velocity between 2000 and 2200 it will pierce solid iron equal in thickness to double its caliber. To obtain the latter degree of perforation at the muzzles of the latest guns the powder-charges must, we believe, be equal to at least one half the weight of the shot. At Gâvre, in 1876, a Whitworth 35-ton gun of 12-inch (maximum) caliber, fired with 120 lbs. P. powder, is reported to have sent a flat-headed steel shell of 808 lbs. through two 8-inch plates; but the experience with flat heads would not lead us to expect so much effect upon a well-constructed two-plate target of this thickness. In 1877 a target composed of four 8-inch rolled-iron plates, with layers of 5 inches of teak between them, was set up at Shoeburyness for the trial of the 80-ton gun of the pattern made for H.M.S. Inflexible and for the turret on Dover Pier. Two rounds were fired—one before and one after the gun had been chambered. The Palliser projectiles weighed 1700 lbs. The range was 120 yards. In the one case the shot was fired with 370 lbs. P^2 powder, and struck with a velocity of 1495 f.-s. and total energy of 26,400 foot-tons; in the other, 425 lbs. P^2 powder gave a striking velocity of 1585 f.-s., and an energy of nearly 30,000 foot-tons. In neither case was the target perforated, though as the shot had got their noses an inch or two into the back plate, it was a good deal cracked and bulged behind. Had the plates been 7 inches instead of 8 inches thick, probably the last shot, at any rate, would have got through.

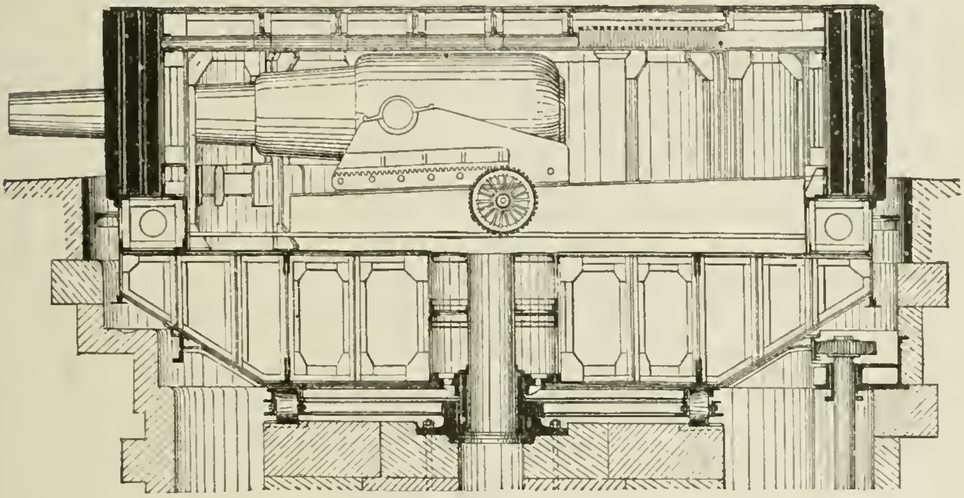
In 1869 a chilled cast-iron casemate front, egg-shaped (thickness of metal about the port 27 inches), underwent a considerable trial, at Tegel, with 72-pdrs. and 96-pdrs., and it stood fairly well. The indents were very slight, but the material, as usual, was extremely brittle, and, to adopt the expressive language of a report quoted in the professional papers of the Corps of Engineers, U.S. Army, it was "pretty well cracked up." The next trial of chilled cast-iron armor was at Magdeburg, in 1874, against a very massive rounded target made by Grüson, and although, both from the form of the structure and the hardness of the material, individual shot were very effectually turned off it, yet repeated blows caused serious injury. Still, the Germans and Belgians have adopted this mode of construction for both shields and turrets—especially for a number of 21^cm^ and 28^cm^ breech-loading muzzle-pivoting guns for the defense of the mouths of rivers. Some of the other European Powers also are using it, to a greater or less extent, for both inland and coast fortresses. The chief advantage of this material is that it can be made of any shape, and therefore rounded and sloping surfaces can be presented to the shot; and it affords also a certain facility for varying at will the thickness of the metal in the different parts of a wall.

As early as in 1859 armor-plates of mild steel and steely iron, and iron and steel combined, and various kinds of steel plates tempered in oil and water, had been tried, and all failed in a greater or less degree when they came to stand the test of shot-blows. So the matter of steel armor rested until the Italians, in 1876, boldly re-opened the question by setting up two armor-plates (made by M. Schneider, of Creusot) of soft forged steel 21¾ inches thick, for trial at Spezia. The plates were about 11 feet long and 4 feet 7 inches wide, and they were backed with massive oak, covering a strong iron skin well supported in rear. For comparison with these, three iron plates of nearly the same dimensions as the steel plates, and similarly supported, were tried at the same time, as well as two plate-upon-plate targets, each consisting of iron plates 11.8 inches and 9.8 inches thick, with 12 inches of wood between them and backing of timber and iron behind them. We must also mention two targets composed of 8-inch wrought-iron plates backed by blocks of chilled cast-iron of "Gregorini" metal, 14 inches thick. In one of these the chilled blocks touched the front armor, in the other 12 inches of wood were interposed. In all the targets there was the same total thickness of 4 feet 4 inches, made up of about 22 inches of armor and 30 inches of timber and skin. The general result of the trial was this: One steel plate was a good deal cracked, and had its end knocked away by two blows from a 10-inch and one from an 11-inch gun, throwing chilled cast-iron projectiles; and the fourth round from the 100-ton gun with a 2000-lb. chilled cast-iron projectile, striking with a velocity of 1500 f.-s. and a muzzle-energy of 31,000 foot-tons, dashed the plate to pieces, though it apparently could not quite perforate it. The other thick steel plate was completely demolished by a single round from the same 100-ton gun. The thick wrought-iron plate made in England was much less injured generally by the lighter guns than was the steel plate, though the indents in it were deeper; but the 100-ton gun sent its shot through all the iron plates, and also broke them in two. The "plate-upon-plate" targets did not do so well as the solid plates, and the targets with the chilled-iron backings entirely succumbed to a single blow on each from the 100-ton gun. The results of the trial were seriously invalidated by the narrowness of the plates used,—a width of 4 feet 7 inches being altogether too little for a plate which is to receive a 17-inch shot, and on this account these costly and elaborate trials at Spezia have afforded much less useful information than they ought to have given. The brittleness of the steel, and its consequent incapacity for resistance to repeated blows, is a striking feature of these trials; the failure of the plate-upon-plate targets, through their being a bad imitation of our construction, is another; the utter collapse of the target with the chilled-iron blocks is a third; and the defective plan of holding armor by screwing bolts into the backs of plates is a fourth. It is to be regretted, also, that these trials did not give us a more exact measure of the armor-piercing power of the 100-ton gun, which was a counterpart of the four which were to be mounted at Gibraltar and Malta. In 1879 the Italians again experimented at Spezia upon thick steel plates. This time the plates were nearly 28 inches thick, and were entirely cased in 1-inch plate boxes, which dispensed with bolting. They were narrow plates, as before (4 feet 7 inches wide and 9 feet long), weight about 20 tons each; but these plates were so utterly destroyed by a single round each from chilled-iron or steel projectiles from the 100-ton gun firing 550 lbs. of Fossano powder, that the trials had to be discontinued without telling much more than was known before. The forged-steel projectile made by Whitworth seems to have penetrated the deepest (21.65 inches) and remained entire, but it was somewhat set up.

Perhaps the shortest way of giving an account of the manufacture of rolled-iron armor will be to say how some one plate in particular has been made, and we will select for this purpose one of the heaviest ever produced. This was one of the 8-inch plates made for the target to test the 80-ton gun at Shoeburyness. Its finished dimensions were: length, 16 feet; width, 10 feet; and its weight 23 tons. For its manufacture 1170 slabs, 30 inches long, 12 inches wide, and 1 inch thick, were made from the puddled ball and bar. These were piled, furnaced, and rolled into 65 plates about 5 feet square and from 1 inch to 1½ inch thick, called small molds. These, again, were piled and rolled into quarter-molds, and the quarter-molds into armor-plate molds, and the pile for the last rolling was made up of three molds about 10 feet square, two of 7-inch and one of 3-inch thickness. As they entered the furnace for this last heating they weighed about 35 tons; as they came out after about twelve hours they weighed 31½ tons. They were rolled down in the last rolling from 17 inches to 8 inches; so that in a certain sense this plate may be said to have been made by rolling a column of iron nearly 100 feet high down to one of only 8 inches high. The fibrous character of a plate depends largely upon the amount of reduction in the last rolling. The rolls are plain cast cylinders; those used in the present case are about 3 feet in diameter, 12 feet long, and each one of the pair weighs nearly 20 tons. They are driven by very powerful steam machinery, and made to reverse their running, so that the plates are sent through one way and then back again, and so on, the rolls being brought nearer together each time until the plate is brought down to the required thickness. The specific gravity of a good iron armor-plate is about 7.625. Armor-plate iron is not made for very high tensile strength, but it is essential that it should draw out well, and reduce in cross-section some 20 or 30 per cent before breaking. As regards chilled cast-iron there is not much to be said further than that Herr Grüson, the principal manufacturer of it, runs his blocks for fortifications direct from cupolas into sand-molds, chilling the faces which are to form the fronts of the blocks against masses of cast-iron. Some of the chills are twice the weight of the casting itself; the chill generally extends two or three inches into the metal. Single blocks have been used as heavy as 50 tons. The cost of these blocks may be taken as rather more than half the cost of wrought-iron armor-plates per ton, but then the cast-iron has to be used in masses more than twice the thickness of the wrought-iron which would give the same protection.

All the most successful compound plates have been made of ordinary armor-plate, iron faced with Bessemer steel. Of course an equally or even better face might be given by using crucible steel, but the cost and difficulty attending the use of this kind of steel would be enormous. In fact, it may be truly said that but for the Bessemer and Martin-Siemens processes it would have been practically out of the question to make compound plates at all. The most simple and effective process of manufacture of these plates is as follows: First, a rolled-iron armor-plate of the usual quality is made, and on it is laid round its edges a wrought-iron frame, the thickness of the armor-plate and the depth of the frame depending upon the thickness required in the finished plate. The plate and frame are then placed in an ordinary plate-heating furnace, and when at a welding heat they are brought out and molten steel made by the Bessemer process is poured out of large ladles on to the surface of the plate up to the brim of the frame. The mass is then allowed to cool, and is afterward re-heated and rolled down into an armor-plate of the desired thickness. The edge of wrought-iron is afterward planed off. Instead of having a simple frame round the edges of the plate it has been proposed to subdivide the surface into squares, as those of a chess-board, in order that by breaking the continuity of the steel the cracks caused by shot-blows may be stopped short, and with the same object it has been proposed to subdivide the steel by fine cuts across its face. The successful union of the steel and iron masses in these plates is very marked. A complete fusion seems to take place, and the natures of the two metals so far intermingle that it is sometimes hard to fix upon an exact line where the steel ends and the iron begins.

The drawing represents the turret for two 80-ton guns at the extremity of the Admiralty Pier at Dover. The work to carry this turret consists of an enlargement of the outer end of the pier. The foundations are laid at a depth of about 7 fathoms below low-water mark, and the guns are at a level of about 33 feet above high water. The structure, therefore, from the bed of the sea to the guns is about 95 feet high. Speaking in general terms, the turret consists first of a live ring and rollers of steel running on a path of steel laid on a massive cylinder of masonry. On this live ring runs a structure of iron framework of the form shown in the diagram, weighing about 240 tons. This framework contains the gun-chamber, which is protected by three thicknesses of 7-inch armor with two intermediate thicknesses of 2-inch plates, making together a weight of about 460 tons. If to these weights be added that of the guns, carriages, and the slides on which they stand, the total running weight will be about 895 tons. This will throw upon each of the 32 rollers of the live ring a pressure due to about 28 tons. The outside diameter of the turret is 37 feet, its internal diameter is 32 feet, the interior height of the gun-chamber is 8 feet 8 inches, the height of the turret-armor is 9 feet. It will be seen that a massive central casting is first held firmly down to the masonry, and that inside this there is a thick cylinder of hammered Bessemer steel surrounding the built-up wrought-iron cylinder which forms the center of the turret framework. We draw attention to this part because, of course, the shock of blows on the turret-walls, or, more strictly speaking, the unabsorbed part of it, ultimately comes to this part, and it has received special consideration on that account. The framework is generally of wrought-iron. The roof of the turret is of strong splinter-proof construction. Over each gun there is a part of it which is removable to admit of its being got in and out, and a part is made of open bars to allow a current of air to clear off any smoke that may enter the turret. The gun-ports admit of 7° of elevation and 2° of depression; the turret is capable of all-round fire. The glacis outside the turret is supported by a ring of armor-plates on edge, 5 inches and 3 inches thick, on a strong circle of 2-inch plating. The muzzles of the guns are brought inside the turret and depressed to an angle of 14° for loading, which is done under the glacis by steam gear. The turret is turned by a pinion, the vertical shaft shown working into a large ring with steel trundles secured to the framework, the power being given by a set of main engines capable of working up to 300 h.-p., and auxiliary engines of 45 or 50 h.-p. For the working and loading of the guns there will be another engine of about 30 h.-p. All the engines and the boilers are in the lower part of the battery, some 30 feet below the guns. The magazines are at nearly the same level as the engines, and the shell-stores at a higher level. There is a system of communication by signal and speaking from the gun-chamber to the engine-room, and throughout the battery.



Turret for two 80-ton Guns.

ARMORER.—The old meaning of this word has nearly passed away with the system to which it belonged. The armor-smiths, or makers of armor, were among the most skilful workers in metal during the feudal times; but their trade afterwards fell away. In the year 1690 the workmen-armorers of London, in a petition to Parliament, complained that their trade was well-nigh ruined. Armorers, in a somewhat different sense of the word, belong to the British army and navy at the present time. There are armorers to every regiment, not to make armor, but to repair arms. There is one to each troop of cavalry, and one to each company of infantry. The armorer is paid one penny per month for taking to pieces and cleaning the lock of each soldier's musket. There is also a regular tariff of prices for every minute detail of repair in the stock, lock, or barrel of muskets, pistols, carbines, and rifles, and in bayonets and ramrods. A school for training armorer-sergeants has recently been established in London to supply one such artificer to each battalion, who shall have a certain degree of control over the ten or twelve company-armorers in the battalion. On shipboard the armorer is a warrant-officer, who has charge of all the muskets, pistols, cutlasses, boarding-pikes, etc., which he is expected to keep clean and in ready order. He is assisted by a subordinate called the "armorer's mate;" and both are skilled in the general routine of smith's work.

ARMORER'S GAUGES.—For verifying the dimensions of the various parts of small-arms are templets of various sizes and shapes, rings, and cylindrical or conical gauges for interior dimensions. Two hundred are embraced in a complete set for the various arms made at the National Armory, of which about 78 are used for the Springfield rifle alone. Of these, the *caliber-gauge* measures the diameter of the bore. The *dimension-gauges* show the length of the barrel and its diameter at various distances, the value in inches and parts being measured by the *caliper-*

gauge. Other gauges measure the proper dimensions of the breech-screw and its thread, and those of the counter-bore of the barrel which receives it; others, again, the form, dimensions, and position of the sights. A separate gauge is required for the lock-plate, and for each separate part of which the lock is composed; as the *mainspring-gauge*, *sear-gauge*, *bridle-gauge*, *tumbler-gauge*, *hammer-gauge*, etc.; also, gauges for the various dimensions of the stock, of the bayonet, and of each of the appendages which accompany the gun. Including the gauges required for inspecting the various carbines and pistols made by different firms in the United States, the number will exceed 1000.

ARMORIAL.—Belonging to armor, or to the arms or escutcheon of a family.

ARMOR PIERCING PROJECTILES.—Projectiles intended for practice at objects composed of wood, masonry, or earth are made of cast-iron; but, since the introduction of iron for the defence of ships and fortifications, a material possessing greater hardness than ordinary cast-iron is required to overcome the resistance opposed by thick wrought-iron plates. Both elongated and spherical projectiles for use against armor should be of the hardest and toughest material possible. The power of a projectile to stand up to its work and deliver its full blow on the target depends on the *shape* as much as on the *quality* of the metal of which it is composed.

The resistance of the plate, neglecting friction, acts as a normal to each point of the surface of contact of a *spherical* projectile; thus, in Fig. 1 it will be seen that the portion of such a projectile included between A and B, which we may term the zone of compression, is subject to a crushing pressure towards the centre, O, but it may be said to be under no tensile strain. While the posterior portion of the projectile is suddenly checked by it in the form of a wedge, when a portion of the work stored up in it (the amount depending on the tensile strength of the material of the projectile) is impressed on the target through the front portion, AOB, while the remainder is carried off unprofitably in the fragments into which the posterior portion breaks. On examining the projectile after impact, a part very nearly corresponding to AOB in form will be found intact (Fig. 1) with the fractured surface scored and polished, while the remainder will be dispersed in small fragments. We know that any casting fractures most easily in the direction of a normal to its surface, the crystals settling themselves so as to form lines on this direction. Theoretically, the portion represented by Fig. 1

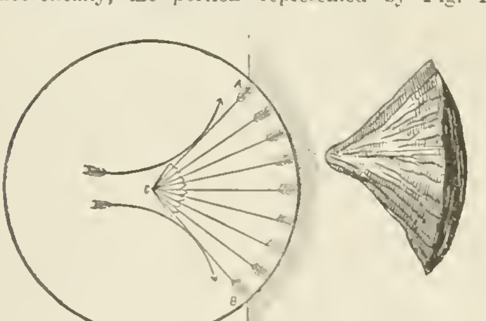


Fig. 1.

ought to be smaller as the penetration is less—except in the case of the entire blow being too small to overcome the tensile strength of the metal in the manner described: when the projectile would only split irregularly, or, in an extreme case, remain entire. In all instances obviously a great amount of the work stored up in the projectile is wasted; not that actually employed in breaking it, for such work is clearly the result of the reaction from the target, but whatever power remains stored up in the fragments after they sever themselves from the mass of the projectile. Since it is impossible to predict what part of a spherical projectile fired from a smooth-bore gun will come in contact with the target on impact, it is necessary that the material should be such as will offer the greatest union of hardness, crushing strength, and tenacity; therefore steel has been resorted to in some instances, and may be regarded as the culminating point of development of the smooth-bore projectiles.

The flat-ended form of *elongated* projectiles possesses a peculiar advantage as regards the projectile, and another as concerns the plate. As to the projectiles, it may be seen (Fig. 2) that in direct impact the whole of the resistance of the target acts in lines parallel to the projectile's axis, which direction is the most favorable to the projectile retaining its mass and delivering its full blow on the target; and, again, if the target is to be punched by actual shearing, the flat head is the form best adapted to effect it. The flat head would probably be best in the case of direct firing against plates composed of hard iron, for it is easy to conceive of a hard material offering very great resistance to the forcing open of a pointed head, which might

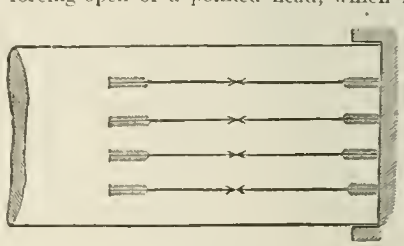


Fig. 2.

be punched by the clean shearing of a flat-headed projectile. The power given by rotation of keeping the same portion of a projectile presented to the front is of peculiar value in punching armor-plates; it enables the head of a projectile to be made of any desired form, while the power of reducing the calibre of a projectile in proportion to its weight, which is perhaps the principal advantage obtained by rifling, is also most important here, the depth of penetration being in inverse proportion to the circumference. In shells, however, this stability of the axis of rotation tells more fully, for it enables every part of the projectile to be made of such proportions as will give the maximum power at the moment of impact. The walls of an elongated shell being chiefly subjected to a longitudinal strain, an interior hollow may be made without entailing the great weakness existing in spherical shells as compared with solid shot. Hence it follows that while smooth-bore shells have seldom or never been fired at armor, rifled shells have proved very successful.

There are two causes which contribute to give shells peculiar power against iron plates. The *first* is that it is not necessary to weaken the head of a shell by making a fuse-hole in it; because no fuse is required, the heat generated on the impact of a projectile against the armor being sufficient to fire the bursting-charge. To such an extent is light as well as heat generated, that on firing at a target after dark a pale flash is seen to follow the impact. The *second* cause that operates to favor the action of shells is the fact that when the shell has penetrated to a depth of even a few inches before rupture occurs, the sides are supported by the armor around them, and the explosion, being confined at the sides, acts to the front with greatly increased force.

In a conical head the normal pressures throughout form a zone of compression acting as a wedge towards the body of the projectile, whose angle is the supplement of that of the cone of the head. This is better than that formed in the spherical head, because the angle is less acute, and because the apex of the wedge, instead of being a fixed point throughout (the center of the sphere), moves along the axis of the projectile as it enters deeper and deeper into the target. In the ogival head (Fig. 3) it will easily be seen how much superior is the action. In this the wedge is at the commencement slightly acute, but then the resistance acts on a small surface and is comparatively small, and the angle increases, till, at the junction of head and body, it becomes 180°, or a straight line, so that we then have the body of the projectile in much the same condition as the flat-headed bolt driving before it an ogival wedge, which opens the armor by

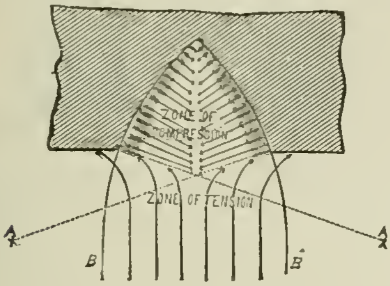


FIG. 3.

wedging rather than by clipping or punching. It is possible, no doubt, to conceive of a material that might be sheared by the flat projectile more easily than opened by the ogival; but it would be to contradict the results of experience to say that plate-iron was such a substance; and as the softer and more plastic natures of plate-iron have been found to hold their bolts the best, and stand the longest, and so have been universally adopted, the ogival has become obviously the correct form of head.

The effect of hardening projectiles is probably much greater than is generally supposed; that is, the amount of work gained is much greater than the increase of strength of the projectile. It is well known that a very small force may under certain circumstances determine the performance or non-performance of a very large amount of work. In like manner a very slight addition to the rigidity of a projectile, by hardening or otherwise, may determine whether a very large amount of work shall be wasted upon the projectile or expended upon the plate. Another means of increasing the work done upon the armor-plate in comparison with that done upon the projectile is by increasing the velocity of the latter. That is, a projectile moving at a low velocity may be smashed up or flattened against the plate, while the same projectile fired at a higher velocity may go through the same plate almost uninjured. On this principle a lead shot may be fired through an iron plate, or a tallow candle through a pine board.

Late trials have shown a superiority of steel projectiles over those made of chilled cast-iron; and although the former are somewhat more expensive than the latter, on the principle that the best is at the same time the cheapest, it would be misplaced economy to leave any means unavailed of to increase the penetrating power of projectiles. The quality of chilled projectiles, from the nature of their manufacture, is necessarily unreliable; whereas this is not the case with hammered cast-steel, or at least not to the same extent by far, even when large masses are produced, and the difficulty of manufacture increases with the calibre. The most essential difference in the behavior of steel and chilled projectiles on striking the target consists in the reaction on the projectile showing itself in the latter by breaking up, while the former are only set up. As the breaking up of the chilled shells may take place before the bursting-charge comes into operation, whereby the rending effect is considerably prejudiced, this material appears far less adapted for shells than steel. The superiority of steel in this respect is still further increased by the fact that the steel shell can have thinner walls, consequently a larger chamber, and can thus hold a larger bursting-charge than the chilled metal.—See *Armor-plates* and *Projectiles*.

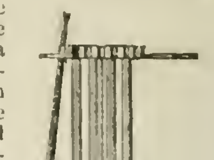
ARMOR-PLATES.—Armor-plates are made of wrought-iron, steel, wrought-iron and steel combined, and cast-iron. Wrought-iron has been found a suitable material for use as armor, owing to its strength, toughness, and malleability. Such plates have been so perfected that they do not break up, but are penetrated by displacement or crowding aside of the material in the path of the shot. Iron plates are either made of a single solid plate or of several iron plates, interlined with some more elastic material. The former are called solid plates, and the latter laminated plates. As the result of many experiments the following conclusions have been arrived at respecting armor-plates of wrought-iron: 1st. The plates should be of soft, tough iron, and, to secure these qualities, should be free from sulphur, phosphorus, and carbon. 2d. Plates made of boiler-iron riveted or screwed together do not give satisfactory results. 3d. Plates made up of several distinct plates bolted together are found to compare favorably with single solid plates of equal thickness. If the separate layers be well held together, each is forced against the one next behind it, and a continuous resistance is offered to the shot during its passage through the mass. If the plates are separated by layers of teak, such a shield stands the racking action of projectiles better than the solid plate, owing to its more elastic nature. 4th. The support given by a rigid backing, such as cast-iron or granite, improves the resisting power of the armor, but leads to its being injured in a greater degree by cracking, and the giving way of fastenings. 5th. The resistance of a plate to perforation is materially increased by a backing of oak or teak, or a compound backing of wood and iron. A backing of concrete has also been found suitable. Such an elastic backing strains the fastenings much less than a rigid one. 6th. A single solid plate has the disadvantage, when compared with the laminated, of deeper joints, causing points of undue weakness. Its manufacture is also more difficult, and will not be so complete as that of laminated plates without great increase of labor and expense. In laminated plates, the surfaces of the plates should not be in contact, but should be separated by some thickness of a softer and more elastic material, such as teak, to prevent their breaking under heavy blows. 7th. Rolled plates are superior to those made by hammering. 8th. The joints of armor are points of weakness, and it is disadvantageous to join plates by tongues and grooves on their edges. They are best held together by wrought-iron bolts, secured by spherical nuts seated in a cup-shaped hole in the armor. The stem of the bolt is of less diameter than the ends, leaving a plus thread. The bolt thus tends to stretch throughout its entire length, rather than pull out of the nut. The enlargement of the holes through which the bolt passes relieves it from cross-strains. Bolts of this kind rather add to the strength of armor. With steel or steel-faced armor, however, where it is essential that the outer surface should be unbroken, the bolts are screwed into the back of the plate and nutted up behind. 9th. An inner iron skin is of great advantage, adding solidity to the backing, and preventing the passage of many splinters.

Steel armor-plates possess some decided advantages over those of wrought-iron, viz., greater absolute tenacity, more perfect homogeneity of structure, and greater resistance to penetration. The disadvantage of steel is that, owing to its crystalline structure, it is liable to crack under repeated blows. Steel armor-plates have been constructed to successfully resist the heaviest gun yet made (1884). In the defensive armament of vessels the main object is to keep out projectiles; and since under ordinary conditions it would be improbable that the plates would be required to receive several blows in the same spot, it has been deemed advisable to substitute for wrought-iron either steel or a combination of steel and wrought-iron as a protection against the heaviest guns. Such a plate would arrest the projectile, although it might be racked to pieces by long-sustained fire. The advantage of wrought-iron over steel is that the effect of a blow is localized, the projectile causing simply a perforation or indentation, the plate as a whole remaining intact. With steel intense molecular action is set up by impact, cracks appear radiating from the point struck, and continue to develop for some time after impact. Thus, though a steel plate may not be perforated, it may be considerably shattered. To combine the greater toughness of wrought-iron with the greater hardness and resistance of steel, compound plates have been introduced. These consist of a wrought-iron foundation-plate with a steel face, the steel being run on the iron plate in a molten state; the whole is then rolled down to about half its original thickness. A modification of this is to have a rolled-steel face-plate attached to the foundation-plate by molten steel, the object being to secure a well-rolled face. The object of welding the steel on the iron is, not to prevent the steel from cracking, but to prevent the fissures from extending through the entire plate, and the iron is intended to hold the steel in its place after being broken, and prevent its falling off. Both chilled-iron and steel projectiles are broken up against these plates, and no experiments yet made have succeeded in destroying the cohesion of the steel face to the iron backing. By the employment of either steel or compound plates, instead of iron, there is a considerable saving of weight. In the more recent experiments (1882) the hammered steel plate of Schneider & Co. (said to contain about 0.45 per cent of carbon) has been found to compare most favorably with compound plates. The surface of this steel plate was chilled in oil to the depth of six inches, and it had been hammered down from a thickness of 7 feet to 18.9 inches. Chilled cast-iron has been extensively employed in land-batteries for the defense of harbors and mouths of rivers. Its advantages are comparative cheapness, great hardness, and the facility with which it can be made into any shape, thus presenting rounded or sloping surfaces to the shot. The main disadvantage of chilled cast-iron is its brittleness, and though, due to the form and hardness of the armor, it can successfully resist a single blow, repeated shocks crack it to pieces. The Grüson system of protecting sea-coast guns is an example of the application of this kind of armor. The turrets are egg-shaped to deflect the shot, the thickness of metal being 27 inches at the embrasures. Thick coverings of earth protect the armor to some extent. These turrets can be adapted to muzzle-pivoted breech-loading guns. See *Armored Defenses*, *Backing*, *Punching*, and *Racking*.

ARMORY.—A building specially provided in Arsenals for the deposit and preservation of small-arms. An Armory should be very dry and well ventilated. In a damp climate a "dry room" would be a desirable adjunct, for, with every care and attention, rust will make its appearance if the outer air is not excluded. The repair of the arms in Armories is usually carried out by civilian armorers. The name is also often applied to a collection of ancient armor and weapons—such as those in the Tower of London, in Sir Samuel Meyrick's Mansion at Goodrich Court on the Wye, and in Warwick Castle. See *Arsenal*.

ARM RACK.—A frame or fitting for the stowage of arms. It is usually vertical, out of harm's way, and in readiness for immediate use. In the conveyance of troops by sea, arm-racks form a part of the proper accommodation. They are also used in the barrack-rooms. Captain F. H. Phipps, of the United States Ordnance Department, has suggested the following description of Arm-rack holding twenty guns:

Top.—Made of two 1-inch white-pine boards, glued together, crossing grain of wood. Diameter of top, 13 inches. Top cut to receive twenty rifles. The guns are held in place and secured by a strap of iron 1 inch wide, leather-covered, hinged, and secured on opposite side by padlock; hinge and padlock-fastening secured by irons, as shown in the drawing.



Bottom.—Made of one 2-inch and one 1-inch white-pine boards, 22 inches in diameter, and one ¾-inch board of white-pine, 12½ inches in diameter, glued together, crossing grain. Twenty triangular-shaped partitions of poplar, 1⅞ inches wide at base by 4⅝ inches long, separate butts of rifles. A band of sheet-iron 1½ inches wide, secured by screws, whose heads are filed to prevent removal, surrounds the upper part of base, the top being flush with the top of partition. Four round pieces of white pine, 1½ inches in diameter and 3 feet 11 inches in length (total), connect top and bottom of frame. A rod of iron, ⅝-inch diameter, with square head at top and threaded for nut at bottom, binds the whole together. In lieu of the four wooden posts and iron rod a single one of gas-pipe might be substituted. The distance between the top and bottom is such that the upper band of rifle just touches the under side of top; and all is so arranged that, without removing the padlock and turning back the straps, no rifle can be removed. The three iron feet which support the whole can be screwed to the floor of the barracks.

Racks for carbines are similarly constructed, differing only in height and in the arrangement of top, which, instead of being cut entirely through to receive the barrel, is cut to the depth of only ⅝ inch to receive the muzzle of the carbine. This rack is almost identical with the one suggested by Major Comly; the principle is the same, but it is stronger, and its cost reduced about one fourth.

ARMS.—1. Instruments of different forms and natures, for attack and defense. The manufacture of arms is of very ancient date, coeval with the world. Necessity drove men to make them, either in defense of themselves against wild animals or against their enemies. The first arms of offense appear to have been made of wood, such as clubs. Arms of stone, bone, and brass succeeded clubs. Subsequently a variety of arms of iron and steel was introduced which comprised the spear, the lance, the hatchet, the battle-ax, the bow, and several others; and though these arms were in many instances rude and unwieldy, the treatment of iron seems to have been well known; in the manufacture of steel great skill was shown, as the blades of Damascus testify, and which were famed throughout the world. In India the tempering of steel was well known from a very early date. The arms of the present day in the British service vary according to the branch of the army in which they are used. In the infantry, the converted Enfield (Snider) rifle was for some time the general arm of the service, but has been superseded by the Martini-Henry rifle. In the cavalry, the sword, lance, carbine, and pistol form the arms of that branch, the dragoon guards, dragoons, and hussars being equipped with the carbine and sword, the lancers with the lance and pistol. In the artillery, in addition to the guns of a battery, the following arms are provided: for a battery of horse-artillery, a sword to each man of all ranks, and twelve carbines for sentry duties; for a battery of field-artillery, a sword to each non-commissioned officer, artificer, or trumpeter, and to all gunners a sword-bayonet, with the addition of twelve carbines for sentry duties. Heavy field-

ARMS OF THE STATES AND TERRITORIES OF THE AMERICAN UNION.

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ARMS OF VARIOUS NATIONS.

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batteries are similarly equipped. Garrison-batteries, all ranks, except trumpeters, are furnished with a complete stand of arms, the trumpeters (and artificers, if any) having a sword-bayonet.

Arms may be divided into two great classes—those that act by means of gunpowder, and those that do not. Of arms that act otherwise than by explosion, the greater part have been in use from the earliest times; they include the bow and arrow, sling, pike, spear, lance, dart, javelin, dagger, ax, mace, spiked or knotted club, scythe for chariots, dirk, bayonet, sword, cutlass, etc., together with such artillery as the ballista, catapulta, and battering-ram. Weapons depending on the use of gunpowder are of two kinds —those that can be held in the hand, and those that are too heavy to be portable. In the first class we find the names of the hand-cannon, hand-gun, arquebus, haquebuts, demi-haque, matchlock, wheel-lock, firelock, currier, snap-haunce, caliver, esclopette, petronel, dragon, hand-mortar, dag, tricker-lock, carbine, fusil, fowling-piece, blunderbuss, pistol, musket or musquet, musketoon, rifle, etc. In the second class, more usually included under the name of artillery, we find the springel, war-wolf, bombard, cart-of-war, culverin, demi-culverin, serpentine, falcon, saker, cannon, howitzer, petard, cannonade, mortar, rifled cannon, war-rockets, etc. The more important of these are briefly noticed under the proper headings. It is needless, perhaps, to add that nine tenths of these are utterly obsolete.

2. Arms, Armorial Bearings, or Ensigns, are the names given to such devices as when painted on a shield form a coat. These terms in popular speech include all the accompaniments of a shield, viz., the crest, helmet, and, where such exist, the supporters, etc. See *Heraldry*.

ARMS OF PRECISION.—Rifled arms of all natures. These arms have a longer range and a more accurate and rapid fire than that derived from the old smooth-bore weapons. The introduction of rifled small-arms of the present form, viz., breech-loaders, only dates back as far as 1864, when in the unequal struggle between Prussia and the Danes the former first used the needle-gun. This called the attention of the European Powers to the value of breech-loading rifles. The further value of such arms was again recognized

Effect of Artillery Fire on Lines of Troops; 9-pdr. and 16-pdr. M. L. R. Guns; line of targets 45 feet long by 9 feet high.

Range.	Nature of Ammunition.	Total Hits. 9-pdr.	Total Hits. 16-pdr.
1500 yards....	Common shell..	46	36
	Shrapnel "	92	345
2000 "	Common "	26	30
	Shrapnel "	75	276
2500 "	Common "	24	36
	Shrapnel "	106	131
3000 "	Common "	13	32
	Shrapnel "	66	105

Front of a company of 50 files, 34 yards long by 5 feet 6 inches high.

Front of a double company of 1 file, 68 yards long by 5 feet 6 inches high.

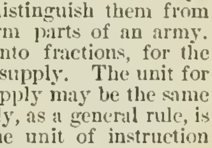
Effect of Infantry Fire, with the Snider Rifle, at the Regulation Targets, and the Proportional Effect on Bodies of Troops in different Formations at various Distances.

Mark aimed at.		Ranges. 200 yds.	500 yds.	800 yds.
Battalion	In line	96.	80.5	59.
	Quarter-column	99.61	98.05	95.86
	Double company ¼-column	99.63	97.73	95.07
½-Battalion	Quarter-company	99.41	97.09	93.85
	Double company ¼-column	99.23	96.18	91.86
Double company	In line	95.89	79.93	57.79
	Company ¼-column	98.77	93.99	87.32
Company	In line	95.77	79.36	56.57
	Half-company column	99.1	95.56	90.59
	Column of sections	98.82	94.17	87.57
Regulation targets, 200 yds., 6 ft. × 4 ft.; 500 yds., 6 ft. × 6 ft.; 800 yds., 6 ft. × 8 ft		90.	61	28.

in the war of 1866 between Prussia and Austria, when the latter power met the former with only muzzle-loaders; the result is well known to history—the superiority and rapidity of the Prussian fire was marked. From this period the value of breech-loaders may be said to have been recognized. France produced her Chassepot, and England the converted Enfield, known as the Snider, ultimately the Martini-Henry; and now all the Continental Armies are armed with breech-loaders. Colonel Hamley, in his "Operations of War," describes the change rifles and rifled guns have brought about in the tactics of armies. No longer is the old formation of battalion-columns resorted to—deep columns offering too good a mark for the enemy. The Prussians, therefore, during the war of 1870, finding such formations no longer safe, diminished the size of their columns in order that the fire of the enemy might prove less destructive both in front and depth, besides giving a better opportunity of taking advantage of the natural cover which average ground affords to small bodies. The tables show the result of practice made with rifled field-guns and rifled small-arms; thus giving the reader an idea of the precision and disastrous effects of rifled arms.

ARMS OF SERVICE.—An arm of service may be defined to be "a union of combatants having the same mode of action." There are four of these arms in modern armies, viz., Infantry, Cavalry, Artillery, and Engineers. These four arms form the principal part of a mobilized army, and as they, or their representatives, are always formed into a line of battle to resist the attack of an enemy, or to make an attack, they are generally known as the "Line of the Army" or "Troops of the Line," to distinguish them from other bodies of men who form parts of an army. These *arms* are subdivided into fractions, for the purpose of instruction and of supply. The unit for instruction and the unit for supply may be the same or different. The unit of supply, as a general rule, is constant, and is also usually the unit of instruction in discipline. The unit of instruction in tactics will depend upon circumstances, and upon the kind of movements which the commander desires to make. The common unit for the four arms, for supplying the men's wants and for instruction in discipline, is the "*Company*." This unit receives, at other times, other names, depending upon circumstances. For instance, a *battery* of artillery is the same as company; the term *squadron* of cavalry frequently means a company, etc.

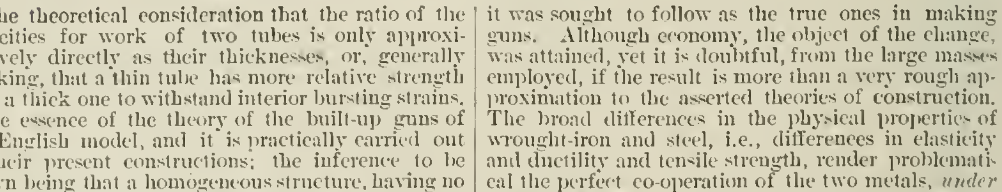
ARMS OF THE UNITED STATES.—Paleways of thirteen pieces, argent and gules; a chief, azure; the escutcheon on the breast of the American eagle displayed, proper, holding in his dexter talon an olive-branch, and in his sinister a bundle of thirteen arrows, all proper; and in his beak a scroll, inscribed with this motto: "E PLURIBUS UNUM."



For the *crest:* over the head of the eagle, which appears above the escutcheon, a glory breaking through a cloud, proper, and surrounding thirteen stars, forming a constellation, argent, and on an azure field.

ARMS PORT.—A position in the Manual of Arms, executed as follows: Being at a carry, the instructor commands: (1) *Arms*, (2) PORT. Throw the piece diagonally across the body, the lock to the front; grasp it smartly at the same instant with both hands, the right at the small of the stock, the left at the lower band, the barrel sloping upward and crossing opposite the point of the left shoulder, the butt proportionately lowered. The palm of the right hand is above, and that of the left under, the piece, the nails of both hands next the body, to which the elbows are closed. The position of *arms port* may be taken in advancing to an attack. It is likewise used by sentinels in receiving or holding communications. In challenging, and receiving the countersign, sentinels take the position of *charge bayonets.* (1) *Carry,* (2) ARMS. Resume the carry with the right hand. (Two). Drop the left hand by the side. See *Manual of Arms,* Fig 10.

ARMSTRONG GUNS.—The built-up gun construction of Great Britain, the germ of which is to be found in the coiled welded system of Sir William Armstrong, introduced to the artillery world in 1852 in the form of a breech-loading cannon, but passing from that date through numerous and important changes, especially the thickening of the coils and the introduction of tempered steel lining tubes, is the one which is still adhered to, in its general principles, by the ordnance constructors, both public and private, of the English nation The failure of the Armstrong breech-loading guns, and the subsequent introduction of muzzle-loading cannon in lieu thereof, in 1869, did not change, however, one of the essential features of the present construction—the employment of coiled welded wrought-iron sections—but led to the modified form of their production known as the Fraser system, and the introduction of comparatively thin oil-tempered steel tubes for the interior lining. The most prominent guns produced under this new system, which first attracted universal attention on account of their great comparative power, were the 25-, 35-, and 38-ton guns; but these, as is well known, were quickly superseded by the 16-inch 80-ton gun, and it, in its turn, by the largest of, as yet, constructed ordnance—the 100-ton guns of the Armstrong model, shown in section in the drawing.



Armstrong Gun.

The theoretical consideration that the ratio of the capacities for work of two tubes is only approximatively directly as their thicknesses, or, generally speaking, that a thin tube has more relative strength than a thick one to withstand interior bursting strains, is the essence of the theory of the built-up guns of the English model, and it is practically carried out in their present constructions; the inference to be drawn being that a homogeneous structure, having no subdivisions in its walls, does not bring into play the full strength of the entire thickness while under stress; and that guns constructed homogeneously, however thick, cannot long sustain pressures exceeding the tensile strength of the metal employed. Sanctioning the soundness of the theory that only by built-up constructions the most powerful and yet reliable guns can be produced, the next point for consideration is the arrangement of the different metals entering into the fabrication, so that the stronger metal (steel) shall form the walls surrounding the bore, and that the superimposed layers of wrought-iron shall be so placed on that each part, from the bore to the exterior, shall be, as far as possible, under strain in accordance with its capacity for work, considered in reference to tangential strains. The English authorities state: "This object we may obtain by employing a single metal for the several portions, and so disposing the various layers over each other that the inner layers or tubes are compressed by those outside them, while the exterior tubes are at the same time put into a state of tension, the inner layers being thus strengthened at the expense of the outer portions of the metal. In this case we obtain the whole strength of all the layers except a part of that of the outer and unsupported ring It must not, however, be for one moment supposed that this theoretical perfection is ever reached; the nearest approach to it is far from perfect, and theoretical advantages have to give way largely to practical considerations of manufacture. Again, we may arrive at a similar result by employing metals varying in elasticity or in tenacity for the several parts, those possessing the largest amount of strength constituting, of course, the inner portions, so that where the greatest stress is felt it will be borne by the stronger material. These two methods are sometimes called respectively those of *initial tension* and of *varying elasticities.* They may be, and frequently are, both employed in the manufacture of a gun, as in the case of the so-called Woolwich guns."

The longitudinal strain is provided for by the thick solid-bottomed steel tube, and the breech-plug screwed into the wrought-iron coiled tube, superimposing the inner tube, brings into play (in the latest model) the strength resulting from locking the tube and other parts together. The construction, briefly, we know is a steel tube, over which is shrunk coiled wrought-iron tubes; the majority of the larger calibers, except the 100-ton gun, having only two layers of wrought-iron tubes; the latter more perfectly brings into use the principles of initial tension, by having the wrought-iron casing subdivided into three instead of two parts. On theoretical considerations, the large number of coils employed in the original Armstrong construction enabled the designers more perfectly to carry out the idea of initial tensions by shrinkage; yet its expensiveness led to its abandonment, and the substitution of larger and, in consequence, fewer coils; thus more imperfectly applying the principles which it was sought to follow as the true ones in making guns. Although economy, the object of the change, was attained, yet it is doubtful, from the large masses employed, if the result is more than a very rough approximation to the asserted theories of construction. The broad differences in the physical properties of wrought-iron and steel, i.e., differences in elasticity and ductility and tensile strength, render problematical the perfect co-operation of the two metals, *under repeated strains* such as obtain in the use of guns; and it would seem that the more elastic and less extensible steel, in imparting its stress to the adjacent iron *repeatedly,* would enlarge the latter by degrees, so that eventually it would form but an imperfect support to the former, which would in that case more or less bear, in the system, the burden of the work in resisting tangential strains; and that its rupture under severer treatment would be finally the result. The manner in which this system in manufacture is practically carried out needs only, in view of the full description printed for public use, be but generally stated.

The tubes are generally of Firth's production, and are furnished under contract to the Woolwich Arsenal. They are solid ingots which are first roughly bored and turned, and then tempered in rape-oil. The jackets or coils, shrunk over the steel tube, in the heaviest natures, range in number according to the length of the gun. Generally two layers of coils cover the breech part, all assembled in accordance with the principle of initial tension. The details of construction are fully given in English text-books, and need not be alluded to here. The 100-ton gun—the latest English muzzle-loading construction—generally speaking, differs from inferior calibers by the large number of shoulders provided on the steel tube, the latter being made in two parts, united together by a wrought-iron exterior band, and in the greater number of subdivisions of the jackets, or rather that the bands are relatively narrower than on other fabrications; besides, three layers obtain at breech, rendering it a more thoroughly built-up gun construction. Four of these guns—made by Sir William Armstrong & Co., Newcastle-on-Tyne—now form part of the armament of Great Britain and her Colonies, and now await their emplacements to be prepared for them at Malta and Gibraltar. We are informed that "guns have already been designed and could be readily made at Woolwich which would surpass the latter [100-ton gun] in power to as great an extent as they themselves surpass the 38-ton service-gun."

The English Government establishment, however, has not produced any muzzle-loading constructions higher than the 80-ton gun, a gun, from the large facilities and perfected machinery of Woolwich, giving us the best exhibit of the Armstrong-Fraser system. That no recent attempts, however, to introduce higher natures of muzzle-loading guns have been made is fully justified by the important developments of Krupp's experiments at Meppen in August, 1879, and by the disasters occurring on board the English ironclad the "Thunderer" in the same year; the first calling attention to the presumed superiority of breech-loading guns—since accorded—in affording less exposure to men; reduced size of embrasures, securing greater rapidity of fire; increased length of bore, and hence greater power; and also affording greater facilities for bore examinations, and permitting an ease in loading not afforded in long-bored muzzle-loading guns; and the latter exhibiting the dangers arising from the possibilities of double charging, and the cumbersomeness and complications of loading devices necessary for the use of muzzle-loading guns, more especially in the naval service, where economy of space is a matter of vital importance. Although the developments at Meppen and the Thunderer misfortune only occurred a few years ago, yet such was the moral effect that immediate steps were instituted to develop breech-loading guns of 12-inch caliber and lower natures.

The principal dimensions of the Woolwich and Elswick guns are as follows:

	Woolwich.	Elswick.
Total length of gun without carrier..in.	333	331
Caliber .... "	12	12
Bore:		
In calibers .... "	26	26
In inches. .... "	312	312 2
Total capacity ....cubic "	39,057	38,734
Chamber:		
Diameter .... "	15 5	14.3
Length .... "	58 35	87.43
Capacity ....cubic "	10,120	13,178
Diameter in rear opening........ "	....	12.4
Rifling:		
Twist in calibers		
Length ....in.	....	220 36
Number of grooves............. "	48	50

These constructions (of the same caliber, 12-inch) differ very little from each other in their main features, such as mode of construction, principal dimensions, breech fermeture, and length of bore, the only important variations being in the lengths and diameters of chambers, and their capacities; the Elswick gun having a less diameter and a greater length for this part of the bore, and also a greater capacity than the Woolwich pattern; this latter feature increasing the air-space in the chamber of the former over the latter when equal charges are used. It also, for the same diameter of the exterior, gives a stronger gun (both using the same metals) in its walls. A tabulated statement of these points of difference may be here inserted:

Powder-chamber.		*Powder-chamber.*	
Elswick:		R. G. F.:	
Length.........in.	86.25	Length .... in.	58.35
Diameter....... "	14.3	Diameter .. ... "	15.5
Capacity..cubic "	13,178	Capacity..cubic "	10,120

The Woolwich authorities have established 17.1 tons per square inch as the service-limit for pressures, yet Armstrong for his constructions reaches 25 tons per square inch, and in his 10.15-inch wire gun a pressure of 34 tons per square inch has obtained. Cast-iron alone, or cast-iron in combination with wrought, or with wrought-iron and steel, or with steel alone, in guns for, say, one caliber and a half thickness of walls, cannot endure the chambering, and in consequence the increased charges, which constructions made of steel alone, or steel in combination with wrought-iron, can sustain; and hence any plan using the inferior metal looking to a rivalry with the superior modern constructions which ignore the use of cast-iron would be a risk too hazardous to assume, and when the pressures reach, in guns using cast-iron, a limit of, say, not exceeding 35,000 to 37,000 pounds for a gun one and one half calibers thick, the service-limit should be regarded as reached, and the charges and chambering should be so regulated as to keep within these limits, which should be established as the limits of safety.

In steel guns a little less than one caliber is regarded as sufficient thickness of walls; and a caliber and one quarter, about, is used over the chambers of the 43-ton guns composed of steel and wrought-iron. In steel-tubed guns, surrounded by a wire and a part steel and part wrought-iron jacket, the thickness of walls given over the chamber is but eighty-five one-hundredths of a caliber. These figures illustrate the vast difference in the eyes of European gun constructors between the use of pure steel and the combination of steel and wrought-iron, and more especially in any construction in which cast-iron plays a prominent part. It would seem, therefore, independent of the recognized fact of the inferiority of cast-iron in strength, that the important element of weight would become largely a factor for consideration in judging of constructions using this metal, either alone or in combination with others. In fact, as much power can be secured from a 43-ton (12-inch) gun (steel and iron) as from a 12-inch 55- to 60-ton gun (built-up) of cast-iron and steel.

In a 44-ton (13-inch) wire gun we have the remarkable exhibit of a yield of 27,460 foot-tons muzzle-energy, or, say, 637 foot-tons per ton of metal. The cast-iron and steel constructions (60 tons) alluded to above only give 359 foot-tons per ton of metal. The 10.15-inch wire gun recently constructed has been tested, and the distinction between it and the last-mentioned gun is more pronounced in favor of wire than the 13-inch; the resulting muzzle-energy giving 760 foot-tons per ton of metal. The pressures are relatively higher in attaining these results, yet the strength of the combination is believed to warrant a large increase over the ordinary standard pressure adopted for the guns of the English service. Admitting that about 27,600 foot-tons muzzle-energy can be attained with a 13-inch of a weight of, say, 44 tons (wire), we find that it takes 50 per centum more weight (60 tons) in a gun (12-inch) using cast-iron to attain a much less muzzle-energy corresponding to the difference in calibers. The force of this testimony regarding weight is evidently, as far as it goes, against the use of cast-iron; and when we consider the question of its employment, pure and simple, this objection of increased weight necessary in the structure becomes a subject of the first importance, and one alone which at the threshold of the consideration of the problem of gun construction should lead us to doubt if it should be employed at all if we desire to attain a high standard in power and endurance in our future heavy ordnance armaments.

Independent of strength and increased weight, cast-iron guns of heavy natures require a cumbersome and expensive plant, consisting of deep pits, large furnaces, powerful cranes, and heavy and powerful lathes, etc., whereas in the built-up steel, and steel and wrought-iron systems, also wire guns, the numerous parts which go to make up the whole can, from their comparative lightness, be handled in the different operations of construction with far greater ease and less expense than obtain in the production of homogeneous masses consisting of but one piece, as found in systems where cast-iron enters either solely or largely into the fabrications. On the score of economy, it may be doubtful if any material advantage results in the use of cast-iron. English models cost about 14 cents per pound. To gain equal powers we would require, according to the ideas of constructors in cast-iron, at least a 60-ton gun to perform the same work as a 43-ton gun of steel and wrought-iron. If we estimate cast-iron at 12 cents per pound, we have a cost of $16,128 for a pure cast-iron gun of 60 tons; and admitting 14 cents per pound for wrought-iron and steel, we have a cost for a 43-ton gun of $13,484.80. If a net profit of 25 per centum for manufacturers is added to this latter figure, which is government cost, we have even then a less expensive construction than pure cast-iron in that country. See *Built-up Guns* and *Ordnance*.

ARMSTRONG PERCUSSION-FUSE.—This fuse is used with breech-loading rifled guns, and is placed below a time-fuse or plug which closes the top of the shell. It consists of three parts—body, pellet, and guard. The *body* is made of gun-metal, and is cast with a bottom through which a fire-hole is drilled, and primed with a perforated pellet of mealed powder, protected by a brass washer. The top, which is fitted in, has a steel point projecting down from its center, and four holes through it closed by a thin brass washer; these holes were intended to allow of the flame from a time-fuse passing into the pellet and so igniting the charge before impact. The body has a rim round it at the top to prevent its being placed in the shell head downwards. The *pellet* (equal parts of lead and tin) has four projections or feathers outside, two rather higher than the others. It is driven with composition like a tube, but has a percussion-cap at the top, protected by a thin brass disk, which can be pierced if driven on to the steel point above by a violent shock; the cap has three holes at the bottom for the passage of the flame from it to the composition below. The *guard* is supported in the upper part of the body on the feathers of the pellet, preventing any forward movement of the latter. On impact, passing the guard, the pellet continues its forward motion; the cap, striking on the steel point, is fired; the flame ignites the composition in the pellet, blows out the washer of the fire-hole in the bottom of the fuse, passes into the shell and explodes it. See *Fuse*.

ARMSTRONG PROJECTILE. — But one kind of projectile is used in the Armstrong breech-loading guns for the field-service, and this is so constructed as to act as a shot, shell, or case-shot, at pleasure. It consists, as shown in Fig. 1, of a very thin cast-iron shell, snugly inclosing forty-two segment-shaped pieces of cast-iron (B B), built up so as to form a cylindrical cavity in the center (D), which contains the bursting-charge and the concussion-fuse. The exterior of the shell is thinly coated with lead (C C), which is applied by placing the shell in a mold and pouring it in in a melted state. The lead is also allowed to percolate among the segments, so as to fill up the interstices, the central cavity being kept open by the insertion of a steel core. In this state the projectile is so compact that it may be fired without injury; while its resistance to a bursting-charge is so small that less than one ounce of powder is required to burst it. When the projectile is to be fired as a shot, it requires no preparation; but the expediency of using it otherwise than as a shell is doubted.

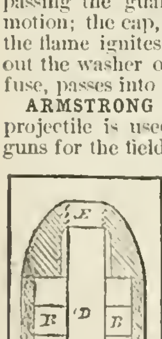


Fig. 1.

To make it available as a shell, the bursting-tube, the concussion- and time-fuses, are all to be inserted; the bursting-tube entering first, and the time-fuse being screwed in at the apex. If the time-fuse be correctly adjusted, the shell will burst when it reaches within a few yards of the object; or, failing in this, it will burst by the concussion-fuse when it strikes the object or grazes the ground near it. If it be required to act as a canister-shot upon an enemy close to the gun, the regulation of the time-fuse must be turned to the zero of the scale, and then the shell will burst on leaving the gun. The explosion of one of these shells in a closed chamber, where the pieces could be collected, resulted in the following number of fragments: 106 pieces of cast-iron, 90 pieces of lead, and 12 pieces of fuse, etc.—making in all 217 pieces.

The Armstrong projectiles for the muzzle-loading guns have rows of brass or copper studs projecting from their sides to fit into the grooves of the gun, which are constructed on the *shunt* principle. Fig. 2 represents a 10-inch Armstrong shell for penetrating armor-plates; It is made of wrought-iron or low steel, with very thick sides. There is no fuse, the explosion resulting from the heat generated by the impact, and the crushing in of the thin cap which closes the mouth of the powder-chamber. The sides and bottom of the shell being thick enough to resist crushing by the impact, and also to resist the explosive force of the bursting-charge, its effect will, after penetration, be expended on the backing of the armor, or the decks which the armor is intended to screen. Such projectiles are called "blind shells." See *Projectiles*.

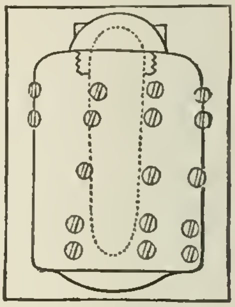


Fig. 2.

ARMY.—An army may be defined as an armed force under regular military organization, employed for purposes of national offense or defense. It may comprise the whole military men employed by the state, or only a portion under a particular commander. When an armed force is under no constituted authority, and imperfect in its organization and discipline, it cannot be said to be worthy of the name of an army, and may be little better than a horde of banditti. Of this nature are the *filibustering* expeditions in which certain portions of the citizens of the United States frequently engage. Through long ages of experience, the principles of military organization, and the laws to which armies are specially amenable, have gradually reached a high degree of perfection. The primitive wars among barbarous people are always stealthy, depending on the forest and the wilderness for their tactics, and considered successful if an enemy can be attacked unawares, despoiled, and carried into slavery. After a time, war advances to the position of an art, and is conducted by men who have received a certain training. An army becomes an instrument not only for vanquishing enemies, but for seizing countries. Even then the highest position of an army is not reached; for the defense of a country requires more military skill, perhaps, and a better organization of troops, than an attack.

Ancient Armies.

Egyptians. — The most extraordinary conqueror among the Egyptians, Sesostris, or Rhamses, lived sixteen centuries before the Christian Era; and although the evidence for his deeds of valor is very questionable, there is reason to believe that the organization of his army can be pretty accurately traced. His father, Amenophis, laid the foundation for the military glory of Sesostris. When the latter was born, Amenophis caused all the male children who were born on the same day as his son to be set apart as a special body, to be reared for a military life; they were taught everything that could strengthen their bodies, increase their courage, and develop their skill as combatants and leaders; and were to consider themselves bound as the chosen dependents or companions of the young Prince. In due time Sesostris became king of Egypt; and then he formed a sort of militia, distributed as military colonists, each soldier having a portion of land to maintain himself and his family. When this militia had been drilled to military efficiency, Sesostris headed them as an army for military conquest in Asia, and placed the chosen band above mentioned as officers over the different sections of the army. *Persians.*—In the great days of the Persian Empire, the flower of the army consisted of cavalry who were distinguished for their bravery and impetuosity of attack. The infantry were little better than an armed mob. The war-chariots, too, though calculated to strike terror when dashing into hostile ranks, were available only on level ground. As to the numbers of men composing the great Persian army, the statements are too wild to be trustworthy. Allowing for all exaggeration, however, it is certain that the Persian armies were very large. When Darius was opposed to Alexander the Great, his army was set down at various numbers—from 750,000 to 1,000,000 men. The king was in the center, surrounded by his courtiers and body-guard; the Persians and Susians were on the left; the Syrians and Assyrians on the right. The foot-soldiers, forming the bulk of the army, and armed with pikes, axes, and maces, were formed in deep squares or masses; the horsemen were in the intervals between the squares, and on the right and left flanks; and the chariots and elephants in front. *Lacedæmonians.*—The Greeks introduced many important changes in armies both in the organization and in the maneuvers. Every man, in the earlier ages of the country at least, was more or less a soldier, inured to a hard life, taught to bear arms, and expected to fight when called upon. The leading men in each State paid attention to organization and tactics in a way never before seen. It was not a standing army, but a sort of national militia, that gained Marathon, Platæa, and Mycale. So far as concerned the arrangement of armies, the Lacedæmonians invented the *phalanx*, a particular mode of grouping foot-soldiers. This phalanx consisted of eight ranks, one behind another; the front and rear ranks being composed of picked men, and the intermediate ranks of less tried soldiers. The number of men in each rank depended on the available resources of the commander. These men were mostly armed with spears, short swords, and shields. *Athenians.*—The Athenians made a greater number of distinctions than the Lacedæmonians in the different kinds of troops forming their army. They had heavy infantry, constituting the men for the phalanx, and armed with spears, daggers, corselets, and shields; light infantry, employed in skirmishes and in covering the phalanx, and armed with light javelins and shields; a sort of irregular infantry, who, with javelins, bows and arrows, and slings, harassed the enemy in march, and performed other services analogous in some degree to those of sharpshooters in a modern army. It is recorded that Miltiades, the Athenian hero at Marathon, invented the "double-quick march," to increase the momentum of a phalanx when rushing on the enemy. *Macedonians.*—Philip of Macedon, the father of Alexander the Great, having the sagacity to see that he could not vanquish his neighbors so long as he adopted the same formation and tactics as themselves, set about inventing something new. He resolved to have a standing army instead of a militia; to have at command a set of men whose trade was fighting, instead of citizens who were traders and soldiers by turn. As a further change, he made the phalanx deeper and more massive than it had been among the Lacedæmonians. He brought into use the Macedonian pike, a formidable weapon twenty-four feet in length. With a phalanx sixteen ranks in depth, four rows of men could present the points of their long pikes protruding in front of the front-rank, forming a bristling array of steel terrible to encounter. Besides these heavy infantry, there were light troops marshaled into smaller bodies for more active maneuvers. Philip organized three kinds of cavalry—heavy, armed with pikes, and defended by cuirasses of iron-mail; light, armed with lances; and irregular. *Thebans.*—This nation introduced the army formation of *columns* much deeper than broad, or having more men in file than in rank. A new kind of tactics was introduced in accordance with this formation; the movement being intended to pierce the enemy's line at some one point, and throw them into confusion. *Romans.*—These able warriors initiated changes in army matters which had a wide-spread influence on the nations of the civilized world. About the period 200 B.C., every Roman, from the age of seventeen to forty-six, was liable to be called upon to serve as a soldier; the younger men were preferred; but all were available up to the middle time of life. They went through a very severe drilling and discipline, to fit them alike for marching, fighting, camping, working, carrying, and other active duties. Every year the Senate decreed the formation of *legions*, or army corps, deputing this duty to the Consul or Prætor. Magistrates sent up the names of eligible men, and Tribunes selected a certain number from this list. The Roman legion, in its best days, had many excellent military qualities—great facility of movement; a power of preserving order of battle unimpaired; a quick rallying-power when forced to give way; a readiness to adapt itself to varying circumstances on the field of battle; a formidable impetuosity in attack; and a power of fighting the enemy even while retreating. The heavy infantry were armed with javelins, heavy darts, pikes, and swords; the lighter troops with bows and arrows, slings, and light javelins; while the defensive armor comprised shields, cuirasses, helmets, and greaves. Those ancient nations which had no distinctive features in their armies need not be noticed here.

Mediæval Armies.

The downfall of the Roman Empire marked the dividing-point between ancient and mediæval times in military matters, as well as in other things that concern the existence of nations. The barbarians and semi-barbarians who attacked on all sides the once mighty but now degenerate Empire gradually gained possession of the vast regions which had composed it. The mode in which these conquests were made gave rise to the *feudal system*. What all had aided to acquire by conquest, all demanded to share in proportions more or less equal. Hence arose a division of the conquered territory; lands were held from the Chief by feudal tenure, almost in independent sovereignty. When European kingdoms were gradually formed out of the wrecks of the Empire, the military arrangements put on a peculiar form. The king could not maintain a standing army, for his Barons or feudal chieftains were jealous of allowing him too much power. He could only strengthen himself by obtaining their aid on certain terms, or by allowing them to weaken themselves in intestine broils, to which they had always much proneness. Each Baron had a small army composed of his own militia or retainers, available for battle at short notice. The contests of these small armies, sometimes combined and sometimes isolated, make up the greater part of the wars of the Middle Ages. Of military tactics or strategy, there was very little; the campaigns were desultory and indecisive; and the battles were gained more by individual valor than by any well-concerted plan. One great exception to this military feudality was furnished by the Crusades. So far as concerns armies, however, in their organization and discipline, these expeditions effected but little. The military forces which went to the Holy Land were little better than armed mobs, upheld by fanaticism, but not at all by science or discipline. Numbers and individual bravery were left to do the work, combination and forethought being disregarded. A much greater motive power for change, during the Middle Ages, was the invention of gunpowder. When men could fight at a greater distance than before, and on a system which brought mechanism to the aid of valor, everything connected with the military art underwent a revolution. Historically, however, this great change was not very apparent until after the period usually denominated the Middle Ages. The art of making good cannon and hand-guns grew up gradually, like other arts; and armies long continued to depend principally on the older weapons—spears, darts, arrows, axes, maces, swords, and daggers. During the greater part of the fourteenth and fifteenth centuries, the chief armies were those maintained by the Spaniards and the Moors on one European battleground, by the English and the French on another, and by the several Italian republics on a third. In those armies the cavalry were regarded as the chief arm. The knights and their horses alike were frequently covered with plate- or chain-armor; and the offensive weapons were lances, swords, daggers, and battle-axes. A kind of light cavalry was sometimes formed of archers on smaller horses. As to army formation, there was still little that could deserve the name; there was no particular order of battle; each Knight sought how he could best distinguish himself by personal valor; and to each was usually attached an Esquire, abetting him as a second during the contest. Sometimes it even happened that the fate of a battle was allowed to depend on a combat between two Knights. No attempt was made until towards the close of the fifteenth century to embody a system of tactics and maneuvers for cavalry; and even that attempt was of the most primitive kind. Nor was it far otherwise with the foot-soldiers; they were gradually becoming acquainted with the use of firearms; but, midway as it were between two systems, they observed neither completely; and the army in which they served presented very little definite organization.

Modern Armies.

The formation of Standing Armies may be said to have introduced the modern military system. When the remarkable exploit of Jeanne d'Arc (Joan of Arc) had enabled Charles VII. to check the victorious progress of the English in France, he set about remodeling his army. By gradual changes, and amid great difficulty, he converted his ill-governed forces into a disciplined standing army. During the reign of his son, Charles VIII. (1483–98), the consequences of this change made their appearance. Charles conducted a well-appointed army into Italy (1494), in support of some pretensions which he had to the throne of Naples. The change made by Charles VII. was not simply that of substituting a compact standing army for an ill-organized medley of feudal troops and of mercenaries; feudalism itself gave way under the influence of this combined with other reforming agencies. So far as concerned the actual formation and discipline of the standing army above noticed, a few changes were from time to time introduced: pistols and carbines were given to the cavalry; cuirasses were worn by the heavy troopers; and new evolutions were introduced. During the Thirty Years' War (1618–48), Gustavus Adolphus and Wallenstein adopted opposite modes of dealing with masses of infantry: the former spread them out to a great width, and only six ranks in depth; whereas the latter adopted a narrower front, with a depth of twenty to thirty ranks. Frederick the Great, in the next century, introduced a most complicated system of tactics and drilling; insomuch that when he could maneuver, he nearly always won his battles; but when the result depended on bold and unexpected onslaughts, he was more frequently a loser than a winner. The great military leader in the early part of the present century, Napoleon Bonaparte, made a larger use than any previous European general of the method of moving masses of troops with great celerity, beating the enemy in detail before they could combine in one spot. It is desirable to present, in the most condensed form, a few statistics of the actual armies of Europe; leaving to other articles all details concerning special armies.

France.—A law passed in 1872 enacts that every Frenchman, with a few specified exceptions, is liable to personal service in the army, and forbids substitution. Every Frenchman not declared unfit for military service, or specially exempted therefrom, must be for five years in the active army (composed of those who have reached the age of twenty years), for four years in the reserve of the active army, for five years in the territorial army, and for six years in the reserve of the territorial army. By the law of July 24, 1873, France is divided, for military purposes, into eighteen regions, each occupied by a corps d'armée, containing two divisions of infantry, one brigade of cavalry, one of artillery, one battalion of engineers, one squadron of the military train. When the present reorganization is completed, the *active* army will be composed of 156 regiments of infantry (line, light, Zouaves, Algerian tirailleurs, etc.), 25 single battalions, and 293 companies (depots, etc.); making in all, for the infantry, 279,986 men; of cavalry, 67 regiments in France, 3 in Algiers, 13 depots of these regiments, and a Cavalry School, comprising 67,888 men; artillery, 40 regiments and 17 companies, with 58,096 men; engineers, 4 regiments, having 13,551 men; of the military train, 11,486 men; in all, for the active army, 441,007. On the war-footing this number would be increased to 1,104,735, without taking account of sanitary corps, gendarmes, etc. Including the *territorial* army, its reserve force, and the reserves of the active army, the total military force of France is 2,505,000. The Budget of 1876 provided for 490,321 men, including gendarmes, etc.

Germany.—By the Imperial Constitution, April 16, 1871, the Prussian obligation to serve in the army is extended to the whole Empire. Every German capable of bearing arms is bound to be in the standing army for seven years, as a rule from the end of his twentieth to the beginning of his twenty-eighth year. Of the seven years, three must be in active service, and four in the reserve. Then he must serve for five years in the landwehr. The whole of the land forces of the Empire form a united army, all the troops being bound unconditionally to obey the Emperor in war and peace. The army of the German Empire consists of eighteen corps d'armée; viz., the corps d'armée of the guard, thirteen Prussian corps d'armée (Nos. I.–XI., XIV.—comprising the troops of Baden —and XV.), the corps d'armée of Saxony (XII.), of Würtemberg (XIII.), two of Bavaria (I. and II.), and the division of Hesse. In time of peace the German army has: (1) of infantry, 146 regiments of the line, 26 battalions of chasseurs, with 4687 commissioned and non-commissioned officers of the landwehr, amounting to 274,711 men; (2) of cavalry, 93 regiments, containing 65,513 men; (3) of artillery, 35 regiments of mounted, 13 of foot artillery, having 45,439 men; (4) of engineers, 19 battalions, 9568 men. In all, with 2056 staff officers, military train, etc., 17,036 officers, 401,659 men. On the war-footing, this force is increased by the following additions: field-troops, 16,976, officers, 676,486 men; depot-troops, 4431 officers, 245,793 men; garrison-troops, 9599 officers, 354,247 men. Total of the German army in time of war: 31,006 officers and 1,276,526 men, with 287,746 horses. The maximum number of troops employed by Germany in the war with France was 1,350,787 men and 263,735 horses.

Austria.—The military forces of the Austro-Hungarian Empire are divided into the standing army, the landwehr, and the landsturm. Subjects of the Empire are universally liable to service. The term of service is ten years, three of which the soldier must spend in active service, being afterwards enrolled for seven years in the army of reserve. He is still further liable to serve two years in the landwehr. The regiments of the standing army are under the control of the Minister of War for the Empire, while the landwehr is controlled by the Austrian and Hungarian Ministers of National Defense. The Emperor-King is the supreme chief of the whole of the military and naval forces of the Empire. The Austrian infantry constitutes 80 regiments of the line, with 148,480 men; the chasseurs, 40 battalions, with 21,451 men; of the cavalry there are 41 regiments (dragoons, hussars, lancers), 43,993 men; of artillery, 13 regiments of field-artillery and 12 battalions of fortress-artillery—in all, 28,695 men. The engineers and pioneers make three regiments, 8898 men. The sanitary troops and military train have 5748 men. The miscellaneous establishments (schools, magazines, etc.) number 25,174. In all, for the active army in time of peace, 284,435 (of whom 253,513 are combatants). On the war-footing these numbers are thus augmented: infantry, 485,680; chasseurs, 59,340; cavalry, 58,671; artillery, 70,614; engineers, 24,502; sanitary troops and military train, 45,727. Then the Austrian landwehr (infantry, chasseurs, and cavalry) comprises 3669 men in peace, 145,045 in war; and the Hungarian landwehr (the Honveds) 13,591 in peace and 206,707 in war. The total of the Austrian military forces in peace-time is therefore 301,695; in war, 1,137,401.

Russia.—According to a law of military reorganization, the Russian forces are to be raised by annual conscription, to which all are liable who have completed their twenty-first year and are not physically incapacitated. Substitution is prohibited. The period of service is fifteen years—six in active service and nine in the reserve. The Russian military forces are composed of regular and irregular troops. The regular troops comprise 164 regiments of infantry, 281,012 men; cavalry, 52 regiments, 42,444 men; artillery, 33,021 men; engineers, 9819 men; train, 4617 men. Total of field-troops in time of peace, 370,913. In war as follows: infantry, 568,253 men; cavalry, 47,379; artillery, 40,846; engineers, 13,306; train, 21,329—total, 691,113. With local and other troops (in fortresses, etc.), and reserve troops, the Russian army in Europe amounts, on the peace-footing, to 19,103 officers and 508,674 men; in war, 22,871 officers and 879,755 men. The army of the Caucasus amounts in peace to 125,643; in war, to 167,841. The army of Turkestan to 22,906; of Siberia, from 25,000 to 27,000. Besides some thousand troops as gendarmes and in various military establishments, there is a grand total for the regular Russian army of 33,000 officers and 733,000 men; on the war-footing, 39,380 officers and 1,213,259 men. In addition there are the irregular troops, comprising about 190,000 men, chiefly cavalry.

Denmark.—All able-bodied young men twenty-one years of age are liable to serve eight years in the regular army of Denmark and eight years in the reserve. Denmark has thirty-one battalions of infantry (guards, line, reserve), comprising 26,750 men; five regiments of cavalry, with 2122 men; two regiments and two battalions of artillery, with 6523 men; two battalions of engineers, with 580 men. The total, line and reserve, is 1031 officers, 35,975 men; on the war-footing, 52,656 men.

Sweden and Norway.—There are five classes of soldiers in Sweden; the enlisted troops, the national militia (indelta), the conscription troops (bevaering or landvaern), the militia of Gothland, and the volunteers. Of the soldiers of the line there is a total of 35,646 men; of the reserve (landvaern), 86,101; of the Gothland militia and volunteers, 150,830. Norway has an army of its own, divided into the troops of the line, with reserve, military train, the landvaern, the civic guards, and the landstorm. The troops of the line are 12,000 in time of peace; in time of war not more than 18,000 without the assent of the Storthing.

Holland.—The army of the Netherlands is formed partly by conscription and partly by enlistment; and there is besides a militia. The European army has, of infantry, 1122 officers and 43,690 men; cavalry, 184 officers and 4318 men; engineers, 1035 men; artillery, 421 officers and 10,610 men. With the staff, etc., the total force is 62,068 officers and men. There is besides in the East Indies a force of 27,659 officers and men.

Belgium.—The standing army is formed by conscription. Substitution is permitted. The legal period of service is eight years. Belgium has 74,000 infantry (16 regiments), 8848 cavalry (7 regiments and 2 squadrons), 14,513 artillery (6 regiments), 2486 engineers. In all, and without officers, 99,847.

Italy.—The Sardinian law of conscription forms the basis of the Italian military system. The infantry of the line under arms on the peace-footing number 86,017; the bersaglieri, 16,818; depots, 11,560; the cavalry, 18,449; the artillery, 19,732; engineers, 3027; carbineers, 20,915; administrative troops, etc., 7047,—giving a total of 183,205. On the war-footing, these several forces are so increased as to give a total of 541,575; and with the addition of the provincial militia, 743,656.

Spain.—The army of Spain was reorganized in 1868 after the model of that of France. The active army has 60,000 infantry, 9000 cavalry, 2500 engineers, and 8500 artillery, making a total of 80,000 men. The reserves increase this number to 216,000. There is besides an army of 54,500 in Cuba, 9400 in Porto Rico, and of 9000 in the Philippines.

Switzerland.—The federal army has 1269 engineers, 8401 artillery, 1942 cavalry, 6078 tirailleurs, 65,991 infantry, and 364 of a sanitary corps. In all, 84,045. There are, besides, of the reserves, 51,102; the landwehr, 65,562,—giving a total available military force of 201,578.

Turkey.—In 1871 the Turkish regular army had infantry to the number of 72,000; cavalry, 9000; artillery, 9500; engineers, 1600; with 1200 miscellaneous troops amounting to 93,300. Before the war of 1877 it was proposed that by 1878 the regular army should be increased to 152,000. The irregulars (Bashi-bazouks, Spahis, etc.) are about 70,000. And the contingents which the Dependent States are bound to furnish are severally: Upper Albania, 10,000; Bosnia, 30,000; Egypt, 15,000; Tunis and Tripoli, 4000.

All the various matters relating to the formation, organization, discipline, arms, equipments, duties, and tactics of armies, will be found succinctly treated under appropriate headings. See *British Army*, *East India Army*, and *United States Army*.

ARMY ADMINISTRATION.—The whole of the operations connected with the raising, clothing, paying, maintaining, and controlling of the British army are included in the term Army Administration. They are distinct matters from military command and discipline. The Sovereign has the supreme command of the British army; but the Secretary of State for War is her responsible representative in all that concerns administration—the Commander-in-Chief being her representative in matters relating to military command and discipline. The Secretary is the organ through whom the wishes of the Sovereign are reconciled with the wishes and intentions of Parliament. Until the war with Russia in 1854, the Administrative Departments were much scattered; their defective organization led in great part to the miseries suffered by the British troops in the Crimea; but now they are all consolidated under the Secretary of State for War.

ARMY CORPS.—When an army is very large, three or four divisions are joined together and form an *Army Corps*. The officer commanding an army corps should be of a higher grade than he who commands a division. This grade, in the U. S. army, would be that of *Lieutenant-General.* An army corps is most generally composed of all arms of service, and is, to all intents and purposes, an army complete in itself. Two or more army corps, or armies, would be under the command of the *General*, or of a "*General-in-Chief.*" It is to be observed that the functions of General Officers are to command armies, or fractions of an army greater than a regiment, when mobilized. In time of peace, when the regiments are not formed into brigades or divisions, but are distributed over districts of country, the function of the General is to command the troops in these districts, which are then designated by the terms "military departments." See *Corps d'Armée*.

ARMY ESTIMATES.—In the spring of every year, the British Government having formed a plan concerning the extent and appliances of the military force for that year, the War Office sends to the Treasury a series of accounts setting forth the probable cost of everything required. The accounts are called the Army Estimates. If they are approved by the Treasury, the Chancellor of the Exchequer adverts to these, along with other estimates, in his annual "financial statement," made to the House of Commons in his capacity as Guardian of the Public Purse. In preparing the Army Estimates the Secretary of State for War applies to the heads of all the departments under him for detailed accounts of their probable requirements. Another functionary then incorporates and adjusts these into a whole; they are submitted to the Treasury; and, if approved, are presented to the House as the Army Estimates. Should the Commons grant the money, the Accountant-General of the War Office makes the requisite drafts or demands from time to time; and the Treasury authorizes the Paymaster-General of the forces to honor these drafts. The money itself is in the Bank of England; this establishment receives a certain annual sum from the government for managing such financial matters.

The Army Estimates are drawn up in conformity with a model which differs little from year to year. There are certain great headings, each comprising many minor divisions, viz.: 1. Regular forces (4 votes); 2. Auxiliary and reserve forces (4 votes); 3. Ordnance establishments and manufactures, and purchases of stores (4 votes); 4. Works and buildings (barracks, fortifications, etc.); 5. Educational establishments (schools, libraries, etc.); 6. Administration of the army; 7. Non-effective services (half-pay, retiring allowances, pensions, etc.). The various items are more or less sifted by the House of Commons; and any one or more of them can be refused altogether, or granted in diminished amount. The Army Estimates for 1879–80, which may be cited here as an illustrative example, refer to the period from April 1, 1879, to March 31, 1880. The total number of men, including the staff of the militia forces, on the home and colonial establishment of the army, and exclusive of those serving in India, was 135,625. The total number serving in India was 62,653, which are charged against the Indian Treasury. The horses were 26,218, of which 10,830 were for Indian service. Without going into any details, we will simply give the amounts under the six great headings:

1. Regular forces—pay and allowances.	£4,914,200
2. Auxiliary and reserve forces.	1,258,500
3. Ordnance services (provisions, clothing, arms, stores)	5,531,000
4. Works and building	853,300
5. Various services (education, administration, etc.)	432,900
6. Non-effective services	2,625,800
	£15,645,700

Similar annual estimates are made for the support of nearly all other armies of the world.

ARMY FRONT.—The great majority of the tactical formations for infantry proposed are practically useless because of an improper connection between the total number of infantry in the army, the number of infantry there should be to each pace of front, and the normal order in which the infantry will move under fire. Let A = the total number of infantry in an army; F, the number of men in the front line; P, the number of paces in that front line; m, the number of infantry which late experience shows there ought to be to each pace of the front; and $2n$, the number of paces in the normal interval between skirmishers (front rank men) when moving under fire, n being the consequent interval between skirmishers, when the front and rear ranks are on the same line, in one rank. Then

$$m\,P = A; \text{ and } P = n\,(F - 1);$$

whence

$$F = \frac{A + m\,n}{m\,n}.$$

Since m, n, and $m\,n$ are always insignificant in comparison to A, F, and P, practically speaking

$$P = \frac{A}{m} \text{ and } F = \frac{A}{m\,n}.$$

Suppose the army in the field consists of 45,000 infantry; from the above, it appears that its front should be 12,000 paces (nearly 6 miles) in extent, and should be occupied by 4000 men. In this case m has been taken as 5 and n as 3, practically a useful interval. Such brief and practical rules as these will at once enable officers in time of war to so place their troops and make such disposition of divisions, brigades, etc., in any position, as to act offensively or defensively and, at the same time, hold in hand troops to turn the enemy's flank, or to prevent the enemy from turning his own. Nothing definite can be laid down as to the distance between the different lines of skirmishers, supports, etc., as everything depends on the nature of the ground.

ARMY HOSPITAL CORPS.—A body of men recruited from the ranks of the English army for the purpose of looking after the sick and wounded, and for carrying out such instructions as may be given to them by the Medical Officers with reference to diet and treatment, and in administering of medicines ordered, and giving such necessary attendance as the sick require. The men act as bakers and cooks, and perform all duties which render them useful to the patients.

ARMY HYGIENE.—In the English army, a branch of the Medical Department having for its object the sanitary condition of the army, whether in quarters or in the field.

ARMY LIST.—The name of a publication issued monthly by authority of the War Office. It contains the names of all Commissioned Officers in the British Army. Then come the General and Field Officers of the dying-out Indian Army. Next the names of all Officers who hold military honors or Staff Appointments. The bulk of the work, however, is taken up with an enumeration of all the regiments in the Queen's Army, and all the Officers in each regiment, arranged according to the numerical rank of the regiments. To this are added lists of the Officers of the Rifle Brigade, Colonial Corps, Royal Artillery, Royal Engineers, Royal Marines, Control, and Army Medical Department; and of Officers retired on full-pay and on half-pay. Next follow the Officers of the Militia, Yeomanry, and Volunteers; and then the Militia and Volunteer Officers of the several Colonies. A full index, an obituary, a list of the changes gazetted during the past month, and of the new regulations, complete the work. A larger work of similar but non-official character, *Hart's Army List*, by a more condensed arrangement of type gives all the information contained in the official list and much in addition.

ARMY MUTUAL-AID ASSOCIATION.—A Mutual-Benefit Society of officers of the United States army, organized January 13, 1879. Its object is to aid the families of the deceased members in a prompt, simple, and substantial manner. Any person actually holding a commission in the army may become a member of this Association, provided he is under fifty years of age, can procure a surgeon's certificate of good health, and is unobjectionable to the executive committee. The initiation-fee is an amount equal to a half-dollar for each full year which the candidate shall have completed on admission. For the purposes of assessment, on the first of January of each year the members are distributed into nine classes, according to their respective ages (determined by the last preceding birthday) at date of classification, and the assessment of the members of the several classes is as follows:

Class.	Assessment.
1. Under thirty years	$2 00
2. Thirty to thirty-five years	2 50
3. Thirty-five to forty years	3 00
4. Forty to forty-five years	3 50
5. Forty-five to fifty years	4 00
6. Fifty to fifty-five years	4 50
7. Fifty-five to sixty years	5 00
8. Sixty to sixty-five years	5 50
9. All over sixty-five years	6 00

The officers of the Association consist of a President, a Vice-president, and a Secretary, who is also Treasurer; all of whom are elected from the members, by ballot, at an annual meeting, and hold their offices for two years and until their successors are qualified. At all of the meetings of this Association, ten members, representing a majority of the whole number, constitute a quorum for business. There is an Executive Committee, consisting of the President, Vice-president, and Secretary, and of two other members, elected at the annual meetings, and holding their offices for one year and until their successors are qualified. A majority of the Executive Committee constitute a quorum for business. The Executive Committee has general supervision over the affairs of the Association; passes upon all applications for membership; prescribes forms; audits all claims and accounts, and decides all questions that may arise in connection therewith; and directs the Treasurer to draw his drafts for all payments. They attend generally to the government and financial affairs of the Association, and have power to fill all vacancies in the Committee until the succeeding election. They meet on the first Monday of each month, or oftener upon the call of the President. The Executive Committee is also empowered, during the lifetime of a member, to revoke or annul his certificate of membership, if it should be made apparent that the same was issued upon a palpable mistake or omission in the declaration of the applicant, or upon an insufficient inquiry by the Medical Examiner as to the condition of his health at the time of his application. The Executive Committee also have power to terminate the membership of any officer who may be dropped from the army for desertion, dismissed by sentence of Court-Martial, or who resigns to avoid trial by Court-Martial; and the Committee have the further power to require, as the condition of continued membership, a new and thorough medical examination by a Medical Officer of the army in the case of any one who the Committee may have good reason to believe shall have become addicted to habits of intemperance or immorality calculated to seriously impair his risk. The Executive Committee may at any time, in the name of the Association, take measures to procure incorporation for it, or petition Congress for such legislation as would in their judgment facilitate the collection of the Assessments, and the custody and disbursement of the funds of the Association, through the Pay Department of the army and the Treasury, or otherwise, as in the judgment of the Executive Committee may seem most expedient. Upon the death of a member the Treasurer, under the direction of the Executive Committee, withdraws from the credit of each member in the special reserve fund the amount of one assessment upon him, or when necessary levy an extra assessment, and the money thus obtained is disposed of as follows: The Treasurer, with the least possible delay, pays to the beneficiary or beneficiaries the net benefit, which is so much of such aggregate assessment, after deducting five per centum for expenses, as shall not exceed a maximum of either twenty-five hundred dollars or a total of three dollars *per capita* of the membership when the death occurs. Any surplus acquired from one aggregate assessment so taken or levied upon a death in excess of these limitations is accumulated in the general reserve fund until the same shall be sufficient to pay a future benefit, when no assessment is appropriated or levied therefor; but such surplus, or so much as may be necessary, is applied to such benefit, and the remainder, if any, carried forward for a like purpose. No benefit is payable by this Association upon the suicide of any member who has not been a member in good standing for more than one year, unless the Executive Committee shall be fully convinced that such suicide was induced by insanity. In case of any one who, having been a member, and having paid all his assessments and dues for more than one year, shall have committed suicide, the fact of insanity shall be presumed in the absence of convincing evidence to the contrary. The decision of the Executive Committee entered upon the minutes of their meeting is, however, finally binding upon all concerned in every case. Any member may change the person or persons designated as beneficiaries by filing with the Secretary a certificate setting forth the fact. Assignments of the benefit to others than widows, children, or other relatives are not, however, to be encouraged, and will not be accepted unless approved by the Executive Committee. The meetings of the Association are held at Washington, D. C. The annual meetings are held on the second Tuesday in January of each year, at which time the Executive Committee audit the accounts of the Treasurer, and submit a report of the transactions of the Association for the preceding year. The proceedings of these meetings, accompanied by the reports and a list of the members, are promptly published for the information of the Association. Special meetings are called upon the written request of ten or more members, and at all meetings the absent members may be represented by proxy, in writing, given to those attending. In order that members may have timely notice of the numerical strength of the Association, and be informed of the basis upon which the number of assessments for each year is computed, the Executive Committee cause to be published in the two military newspapers which have the largest army circulation, as early in the beginning of each year as practicable, a notice which gives the total membership of January 1st, and the number of assessments payable by each member.

It is proposed that additional groups, not exceeding two, may be formed whenever one hundred members of the Parent-Association (having signified their desire to join the same) have been duly accepted by the Executive Committee. Of the additional groups authorized to be formed, the first group formed is designated and known as Group B, and the second as Group C. For purposes of assessment members of Groups B and C are separately classified, and the assessment of members is as follows:

Class.	Assessment.
1. Under thirty years	$4 00
2. Thirty to thirty-five years	5 00
3. Thirty-five to forty years	6 00
4. Forty to forty-five years	7 00
5. Forty-five to fifty years	8 00
6. Fifty to fifty-five years	9 00
7. Fifty-five to sixty years	10 00
8. Sixty to sixty-five years	11 00
9. Sixty-five to seventy years	12 00
10. Seventy years and upwards	13 00

The funds of the Parent-Association are not in any case whatever, or in any manner, either temporarily or otherwise, applicable to or to be used in the payment of the expenses or liabilities of the groups; and the expenses, liabilities, and benefits of Groups B and C are borne by the members thereof respectively, and the records, accounts, and funds of each group are kept separate and distinct, and in no case are the funds pertaining to one group applied to or used in payment of the expenses, liabilities, or benefits of any other group. The membership, classes, and assessments, January 1, 1884, were as follows:

Class.	Membership.	Assessments.	Amount.
1	105	$2 00	$210 00
2	131	2 50	327 50
3	133	3 00	399 00
4	202	3 50	707 00
5	167	4 00	668 00
6	90	4 50	405 00
7	28	5 00	140 00
8	16	5 50	88 00
	872		$2,944 50

ARMY OF OBSERVATION.—The question of moving out to meet a relieving army involves, frequently, the question of raising the siege. If the besieging army is strong enough to permit it, a force is usually detached to watch the movements of the relieving army, while the main body remains prosecuting the siege operations. This detached body is known as an Army of Observation. No important siege should be undertaken where there is danger from a heavy succoring force from without, unless the besieging force is of sufficient strength not only to keep the garrison within their works whilst the ordinary siege operations are pushed forward, but to detach a force of sufficient strength to observe the movements of any body that may seem large enough to threaten the besieging force and to hold it in check long enough, if attacked, to concentrate the entire force on some favorable defensive position.

ARMY ORGANIZATION.—Napoleon, at the period of the preparations for his descent upon England, had a moment of leisure which he could bestow upon his military organization. Then, for the first time, it is believed, was introduced a systematic organization of grand masses, termed *Army Corps;* each one comprising within itself all the elements of a complete army, and apt for any emergency. Since then this has served as a type to France and other European States in their organization. An army is now composed of one or more army corps, made up of infantry and cavalry; an artillery equipage, comprising several batteries; several artillery parks of reserve; with a grand one to which is attached a bridge-train. Each army corps consists of one or more Divisions; each division of several Brigades; the brigade comprising two Regiments. Two batteries of foot-artillery, of six pieces each, are attached to each infantry division; and one of horse-artillery, of the same strength, to each division of heavy cavalry. Besides, for each army corps of infantry there is a reserve of several batteries; and a few served by foot-artillery. In some cases, one of the batteries of reserve is served by the horse-artillery. A company of engineer troops, termed *Sappers*, is generally attached to each infantry division; and to each infantry army corps a brigade of light cavalry, with a company of *Pontoniers*, which has charge of the bridge-train. In France, each brigade is commanded by a *Maréchal de Camp*, a grade corresponding to our Brigadier-General; each division by a *Lieutenant-General*, which corresponds to our Major-General; and an army corps by a *Maréchal de France.* The particular organization of the General Staff, and the different arms of service, would lead to details of no importance here. The proportion, however, of each arm of an army to the others is a subject of great interest, as upon this depends, in a great degree, the more or less of excellence in the military institutions of a State. The infantry, from its powers of endurance, its capabilities for battle in all kinds of ground, and its independence of those casualties by which the other arms may be completely paralyzed, is placed as the *first arm;* and upon it is based the strength of all the others. It generally forms about *four fifths* of the entire force. In all States where the military art is justly appreciated the cavalry arm is placed in the *second rank* to the infantry. To it an army is often indebted for turning the scales of victory, and giving a decisive character to the issue. To it, the infantry, when exhausted by fatigue, or broken, often owes its safety, and through the respite gained by its charges finds time to breathe and re-form. Without it, much of advanced-post duty, patrols, and detachment service requiring great celerity would be but badly performed. But the arm of cavalry by itself can effect but little, and, in many circumstances, does not suffice even for its own safety. The smallest obstacles are sufficient to render it powerless; it can neither attack nor hold a post without the aid of infantry; and at night is alarmed, and justly so, at every phantom. The proportion borne by the cavalry to the infantry should vary with the features of the seat of war; being greater in a champagne than in a broken or mountainous country. The proportion of *one fourth* of the infantry for the first, and *one sixth* for the last, is generally admitted by received military authority as the best. The artillery is placed *third in rank* among the arms. Its duties are to support and cover the other arms; keep the enemy from approaching too near; hold him in check when he advances; and prevent him from *debouching* at particular points. To perform these duties it is considered that an allowance of *one piece for each thousand men* of the other arms, and *one in reserve*, forms the proper quota of this arm. It is to be remarked, however, that this proportion supposes the other arms in an excellent state of organization and discipline. In the contrary case, the quota of artillery must be increased; for it inspires poor troops with confidence, as they rely upon it to keep off the enemy, and to cover their retreat. But here arises another disadvantage, as artillery is utterly incapable of defending itself, and therefore, when present in an over-proportion, it must necessarily sustain great losses in guns and the other *matériel*. The arm of engineering, although requiring more science and a higher grade of talent for its duties than any other, takes the *last place in tactical considerations.* To it is intrusted all that pertains to opposing passive obstacles to an enemy's advance, and removing those which he may have raised. To it is assigned that most difficult of all tasks to the soldier, patient endurance of manual toil, and a disregard of everything but the work in hand, whilst exposed to the enemy's fire. The proportion of engineer troops will depend in a great measure upon the character of the operations undertaken; being most in sieges, and least in those depending mainly on maneuvers. In the French service the engineers are one half the strength of the artillery —a large number, but rendered necessary by the peculiar military position of that country. The troops which compose the three principal arms are generally subdivided into two classes, *heavy* and *light;* partly arising from the nature of their weapons, and partly from their destination on the field of battle. This subdivision is less marked in the infantry than in that of the other arms; for although in most foreign armies a portion of the infantry carries a saber with the musket, still this additional weapon is of rather questionable utility; for the musket is the one which, under all circumstances of attack and defense, will be resorted to. All infantry now receive the same instruction; but whether a portion of it ought not to be reserved especially for the duties consigned to light troops is still a disputed point. One thing is certain, that perfection is more easily reached by confining the individual to one branch of his art than by requiring him to make himself conversant with the whole. Still it might be often found inconvenient, at the least, if infantry were not able to perform all the functions required of it. The service of light infantry often demands great individual address, intelligence, and well-developed physical powers—a combination of qualities not easily found, and seldom, indeed, without careful habitual training. Whereas, in infantry of the line, the qualities of the individual are of less importance, as results here depend almost solely upon the action of the mass. The habitual order of battle of light infantry is the *dispersed order;* and whether acting offensively or defensively, it depends for its results upon the effect of its fire, resorting to the close order, and using the bayonet only exceptionally. As each individual, although immediately supported by his own file-closer, and those on his right and left, is still often thrown upon his own resources, being obliged to take cover where he can most conveniently find it, he must be a good marksman, cool, deliberate, and circumspect; since it may become necessary to keep an enemy occupied hours and even days together, pressing on him at one moment and yielding to him the next, or hold with tenacity, and disputing inch by inch some particular point, as it may suit the views of the General in command. In infantry of the line, as success depends upon the action of the mass, *ensemble*, coolness, and determination should characterize all its movements, whether it delivers its fire in line, forms in column to attack with the bayonet, or throws itself into square, to await the charge of the enemy's cavalry. The duties of light infantry are to open an engagement, and, after it is fairly got under way, to keep it going; turning it to advantage if successful, otherwise breaking it off. In its relations to the infantry of the line, it should cover the flanks of the latter; clear the way for its advance by rooting the enemy out of all covers, and then holding them if requisite. Upon it devolves all advanced-post, detachment, and advanced- and rear-guard service. To the infantry of the line is confided everything where firmness is the essential requisite: as the attack or defense of key-points, the formation of all supports and reserves, whether on the field or in the attack and defense of posts. There is a third class of infantry, termed *riflemen*, which does not form a part proper of the arm of infantry; partaking, when properly constituted, more of the character of partisan than of regular troops; being chosen only from that portion of a population whose habits lead them to a daily use of fire-arms and give them an unerring aim. As an auxiliary in the defense of particular localities, where they are secure from the attack of the bayonet, or of cavalry, and can deliver their fire with that deliberation which their weapon demands, riflemen will often be found invaluable; as nothing is more dreaded by troops generally than this lurking and often invisible foe, whose whereabouts is only divined by the destruction he deals around him. In cavalry, the distinction between heavy and light is more strongly marked, and the functions of each more clearly defined than in infantry. The *cuirassiers*, from their defensive armor and heavy saber, which in both man and horse call for great physical powers, constitute the true heavy cavalry. The *dragoons* and *hussars* belong to the light, and the *lancers* indifferently perform the functions of either. The most essential quality of all cavalry, which distinguishes it from all other arms, and gives it the faculty of taking an enemy frequently at disadvantage, is that of celerity. If to this the rider unites boldness, and even, when called for, recklessness, it makes of this arm a truly fearful one. Cavalry, to attain its ends, should unite several essential conditions; horses and weapons in good condition; sufficient depth of ground both in front and rear to gather speed for the charge, or space for rallying; to be led boldly but skillfully into action; have its flanks covered against a surprise; and be followed by a support, or reserve, to cover the retreat, or secure from the effects of confusion the line charging, if brought up unexpectedly by the enemy. As the functions of heavy cavalry are to bear down all opposition and present an impassable wall to the enemy's efforts, its duties are confined to the battle-field; there, placed in the reserve, it is held in hand until the decisive moment arrives, when it is launched forth to deal a blow from which the enemy hopelessly struggles to recover, either to achieve victory or to fend off utter defeat. To light cavalry are intrusted the important duties of securing from surprise the flanks of the heavy; to watch over the safety of horse-artillery, and to perform the services required of them by infantry divisions, and those of detachment service in general. The artillery, which had for a long period, and even still, preserves the character of eminent respectability, has of late years begun to infuse a dash of the dare-devil spirit of the cavalier into its ranks. If it has not yet taken to charging literally, it has, on some recent occasions, shown a well-considered recklessness of obstacles and dangers, fully borne out by justly deserved success. The distinction between light and heavy in this arm arises not only from the difference of caliber in the pieces, but also in a difference of their tactical application. The heavy field-caliber is reserved for batteries in position, and is seldom shifted during the action. The light field-caliber are served either by foot- or horse-artillery, and follow the movements of the other arms. Improvements both in the *matériel* and the tactics of artillery have been very marked within late years. Formerly, considered only in the light of an auxiliary on the battle-field, artillery now aspires, and with indisputable claims, to the rank of a principal arm. The tactical applications of artillery on the field depend on the caliber. To the heavy are assigned the duties of occupying positions for strengthening the weak points of the field of battle; for securing the retreat of the army; for defending all objects whose possession might be of importance to the enemy, as villages, defiles, etc.; and for overturning all passive obstacles that cover the enemy, or arrest the progress of the other arms. The light pieces, served by foot-artillery, follow the movements of the infantry; covering the flanks of its position, preparing the way for its onset, and arresting that of the enemy. It is of this that the principal part of the artillery in reserve is composed. The horse-artillery is held in hand for decisive moments. When launched forth, its arrival and execution should be unexpected and instantaneous. Ready to repair all disasters and partial reverses, it, at one moment, temporarily replaces a battery of foot, and at the next is on another point of the field, to force back an enemy's column. In preparing the attacks of cavalry, this arm is often indispensable and always invaluable; brought with rapidity in front of a line, or opposite to squares of infantry, within the range of canister, its well-directed fire, in a few discharges, opens a gap, or so shakes the entire mass that the cavalier finds but a feeble obstacle where, without this aid, he would in vain have exhausted all his powers. See *Army*.

ARMY REGISTER.—The official list of the United States army, published annually, showing the position, rank, and duties of officers, regiments, companies, etc., with the promotions and casualties during the preceding twelve months.

ARMY REGULATIONS.—A book so called, published in the name of the President of the United States "for the government of all concerned." The Constitution provides that "Congress shall have power to make rules, for the government and *regulation* of the land and naval forces." The only Acts of Congress in force authorizing the President to make regulations better defining the powers and duties of officers are contained in the 5th section of the Act of March 3, 1813, and the 9th section of the Act approved April 26, 1816. The first of these acts is an act for the better organization of the General Staff of the army, and the second relates (with the exception of the last section, concerning forage and private servants) to the same subject. By the 5th section of the Act of 1813 it is provided, "That it shall be the duty of the Secretary of the War Department, and he is hereby authorized, to prepare general regulations better defining and prescribing the respective duties and powers of the several officers in the Adjutant-General, Inspector-General, Quartermaster-General, and Commissary of Ordnance Departments, of the Topographical Engineers, of the Aides of Generals, and generally of the General and Regimental Staff; which regulations, when approved by the President of the United States, shall be respected and obeyed until altered or revoked by the same authority. And the said general regulations, thus prepared and approved, shall be laid before Congress at their next session."

Remarking here that the regulations to be prepared and approved refer *only* to the powers and duties of the officers of the several Staff Departments enumerated in the Act, it follows that no other regulations made by the President can derive any force whatever from this Act. The 9th section of the Act of 1816 therefore only continued this then existing power of the President in providing "That the several officers of the Staff shall respectively receive the pay and emoluments, and retain all the privileges, secured to the Staff of the army by the Act of March 3, 1813, and not incompatible with the provisions of this Act; and that the regulations in force before the reduction of the army be recognized, as far as the same shall be found applicable to the service; subject, however, to such alterations as the Secretary of War may adopt, with the approbation of the President." It would seem, therefore, that whatever may be contained in the President's army regulations of a legislative character concerning officers of the army not belonging to Staff Departments must, if valid, be a legitimate deduction from some positive law, or depend for its legality upon the exercise of authority delegated to the constitutional Commander-in-Chief or other Military Commander, in the rules made by Congress for the government of the army. Congress has delegated to the President authority to prescribe the uniform of the army; authority to establish the ration; and besides the authority given by law to other Military Commanders, he also has been authorized to relieve, in special cases, an inefficient Military Commander from duty with any command; to assign any senior to duty with mixed corps, so that the command may fall by law on such senior in rank; to limit the discretion of Commanding Officers in special cases, in regard to what is needful for the service; and hence also he has been given authority to carve out special commands from general commands in particular cases. These are all-important functions, but they do not authorize *special cases* to be made general rules, and it is much to be regretted that the lines of separation between regulations and the orders of the Commander-in-Chief have not been kept distinct.

ARMY RESERVE.—A force, under the present organization of the British army, composed of men who have enlisted for twelve years, a portion of which service, viz., six and not less than three years, must be passed with the colors, the residue being spent in the reserve. This condition of service is known as "short service." Other soldiers are eligible to enter the reserve force, viz., those who have exceeded the first term of their engagement, say men after thirteen or fourteen years' service, and who do not exceed thirty-four years in age. Under the system which now obtains, a considerable reserve force may be expected to be formed, and it is estimated that with an army of 180,000 men, of whom three fourths are to serve only six years with the colors, there will accrue by 1882 a large reserve of trained men, all under thirty-two years of age.

The Army Enlistment Act of 1867 formed a body of men called the enrolled pensioners and others into two classes: First class, not exceeding 20,000 men, liable for service anywhere, and consisting of men who are serving or have served in the army, and whose service does not exceed first term of enlistment. Second class, not exceeding 30,000, liable for service in the United Kingdom only, consisting of persons already enrolled, out-pensioners. The Act of 1870 has modified the above, and the result has been that enrollment for second class, except for pensioners, has been suspended. (Second class therefore consists entirely of enrolled pensioners, who are called out for twelve days annually, under S. O. of Pensioners, and number about 15,000.) Enrollment in the first class is encouraged, and men are eligible to enter this class up to the age of thirty-four; the retaining fee amounts to £6 per annum (but no claim to future pension), and all men enlisted under short service are to be passed into this class, who will ultimately be the reserve of the standing army.

ARMY SCHOOLS.—The colleges, academies, and schools relating to military matters may be grouped into three classes—those intended to increase the military efficiency of the officers and men; those for imparting military knowledge to persons not yet in military service; and those which bear relation to the ordinary school-tuition of soldiers of the ranks and their children. The principal of those in the first group are the Royal Military College at Sandhurst, the Royal Military Academy at Woolwich, the School of Instruction at Chatham, the Department of Artillery Studies at Woolwich, the School of Artillery at Shoebury, the School of Musketry at Hythe, the Royal Artillery Institution at Woolwich, and the United States Artillery School. The chief among the second group are the Royal Military Asylum (better known as the Duke of York's School), the Regimental Schools, the Garrison Schools, and the United States Military Academy. Chelsea College or Hospital is an Asylum for veterans, not a school of instruction. Most of these educational establishments will be found most briefly described in this work, either under the names of the places where they exist, or of the arm of the service to which they belong.

ARMY SERVICE CORPS.—A branch of the Control Department, in England, officered from the Supply and Transport Sub-department. The officers of this corps rank as follows: Commissary-Major, Deputy Commissary-Captain, Assistant Commissary-Lieutenant. The corps consists of clerks, tradesmen, mechanics, skilled laborers, drivers, etc., who are required for the various duties connected with the supply, store, pay, and transport service.

ARMY WAGON.—A wagon designed for the use of foot-soldiers on the plains, and so constructed that the men can quickly jump off the seats when attacked, and spring back again at once. The term is also applied to wagons for stores and ammunition.

ARMY WORK CORPS.—When the British generals engaged in the Crimean War, in the latter months of 1854, knew that the siege-army would need to winter outside Sebastopol, grave difficulties were presented to their notice. The distance from the landing-place at Balaklava to the front of the siege-camp was not less than eight miles; and the only road was a mud-track, almost impassable in wet weather. How to get the heavy guns, the shot and shell, the provisions and the general stores up to the front was a question not easy of solution. The British soldiers were too few even for the ordinary military duties, and yet they were called upon for services of an extra and arduous nature. When these facts became known in England, a suggestion was made that an "Army Work Corps" should be formed, to consist of strong and efficient railway excavators, Cornish miners, and well-sinkers; that these should have with them all the tools and appliances for making roads and digging wells; and that they should be accompanied by traveling workshops and skilled artisans, to effect that which might require more skill than physical labor. The immediate necessities of Lord Raglan, in regard to bringing up supplies, were met by the construction of a railway from Balaklava to the heights outside Sebastopol, by special contract with Messrs. Peto & Brassey; but the large amount of bodily labor continually needed for various services led to the formation of the Army Work Corps. The raising and organization of this force were intrusted to Sir Joseph Paxton. As soon as he had obtained 1000 efficient men he sent them out; and their value was so soon felt by Lord Raglan that other detachments gradually followed, until the corps comprised 3500 men in the latter months of 1855. The men were paid well and they worked well; and as their engagement related only to the special duties connected with the siege-camp, the country was not saddled with any burden after the need for these services had ceased. They did not require to be drilled for their duties, like sappers; and they were ready for work at once, as artisans or laborers. There were some cases of disagreement between the men and their employers, after the whole of the British had returned from the Crimea, in a matter of wages due; but this was a question of detail, and did not affect the usefulness of the corps. The experience gained has been valuable, as showing in what way, under special circumstances, ordinary workmen and laborers may be employed as assistants to a military force.

ARNAOUTS—ARNOUTS.—A corps of Grecian militia organized during the war of Russia against the Porte in 1769.

ARQUEBUS.—The first form of hand-gun which could fairly be compared with the modern musket. Those of earlier date were fired by applying a match by hand to the touch-hole; but about the time of the battle of Morat, in 1476, guns were used having a contrivance suggested by the trigger of the arbalest or cross-bow, by which the burning match could be applied with more quickness and certainty. Such a gun was the arquebus. Many of the Yeomen of the Guard were armed with this weapon, on the first formation of that corps in 1485. The arquebus being fired from the chest, with the butt in a right line with the barrel, it was difficult to bring the eye down low enough to take good aim; but the Germans soon introduced an improvement by giving a hooked form to the butt, which elevated the barrel; and the arquebus then obtained the name of the *haquebut.* Frequently written *Arquebuse, Harquebus,* and *Harquebuse.*

Arquebusier.

ARQUEBUSADE.—Shot of an arquebus. Also distilled water from a variety of aromatic plants, as rosemary, millefoil, etc., applied to a bruise or wound; so called because it was originally used as a vulnerary in gun-shot wounds.

ARQUEBUSIERS.—Soldiers armed with the arquebus and haquebut. The former were common in the English army in the time of Richard III., the latter in that of Henry VIII.

ARRAY.—Order of battle, as an army in battle *array;* disposition in regular lines.

ARRAYER.—A title given to certain military officers in England in the early part of the fifteenth century. There were two of them in each county, sometimes called Commissaries of Musters. Their duties were set forth in an ordinance of Henry V., from the terms of which it appears that the Arrayers were Army Inspectors, or, rather, Militia Inspectors, and in some sense precursors to the modern Lord-Lieutenant of Counties.

ARREST.—1. A French word, similar in its import to the Latin word *Retinaculum.* It consisted of a small piece of steel or iron which was formerly used in the construction of fire-arms to prevent the piece going off. A familiar phrase among military men in France is, *Ce pistolet est en arrêt.*—"This pistol is in arrest," or "is stopped."

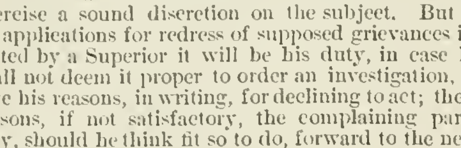
2. The temporary confinement of officers in barracks, quarters, or tents, pending trial by Court-Martial, or the consideration of their imputed offenses previous to deciding whether they shall or shall not be tried. Private soldiers are usually placed under guard, and non-commissioned officers are placed in arrest in quarters. None but Commanding Officers have power to place officers under arrest, except for offenses expressly designated in the Twenty-fourth Article of War. Officers are not put in arrest for light offenses. For these the censure of the Commanding Officer will, in most cases, answer the purposes of discipline. An officer in arrest may, at the discretion of his Commanding Officer, have larger limits assigned him than his tent or quarters, on written application to that effect. Close confinement is not to be resorted to unless under circumstances of an aggravated character. In ordinary cases, and where inconvenience to the service would result from it, a Medical Officer is not put in arrest until the Court-Martial for his trial convenes. The arrest of an officer or the confinement of a soldier is reported to his immediate Commander as soon as practicable. All prisoners under guard, without written charges, are released by the Officer of the Day at guard-mounting, unless orders to the contrary be given by the Commanding Officer. On a march, Field-officers and Non-commissioned Staff-officers in arrest follow in rear of their respective regiments. Company officers and Non-commissioned officers in arrest follow in the rear of their respective companies, unless otherwise specially ordered. An officer under arrest does not wear a sword, or visit officially his Commanding or other Superior Officer, unless sent for. In case of official business he makes known his object in writing. Whenever officers are ordered in arrest, or for trial, from their proper stations to other military posts, they may, during the time they remain at such posts under arrest, awaiting trial or sentence, be allowed to occupy public quarters provided there are any vacant that can be assigned to them without infringing upon the rights of other officers regularly stationed on duty at the post. Under these circumstances they forfeit any and all claims they may have had to quarters in kind, or commutation therefor elsewhere. See *65th Article of War.*

ARRESTE OF THE GLACIS.—In fortification, the junction of the talus which is formed at all the angles.

ARREST IN ORDER OF TRIAL.—Before an officer or soldier, or other person subject to military law, can be brought to trial, he must be charged with some crime or offense against the Rules and Articles of War, and placed in arrest. The Articles of War direct that whenever any officer shall be charged with a crime, he shall be arrested and confined in his barracks, quarters or tent, and deprived of his sword by the Commanding Officer. And that "Non-commissioned officers and soldiers, charged with crimes, shall be confined until tried by a Court-Martial, or released by proper authority." The arrest of an officer is generally executed through a Staff-Officer; by an Adjutant, if ordered by the Commanding Officer of a regiment; or by an officer of the General Staff, if ordered by a Superior Officer; and sometimes by the officer with whom the arrest originates. On being placed in arrest, an officer resigns his sword. If this form be sometimes omitted, the custom is invariably observed of an officer in arrest not wearing a sword. By the custom of the army, it is usual, except in capital cases, to allow an officer in arrest the limits of the garrison or even greater limits, at the discretion of the Commanding Officer, who regulates his conduct by the dictates of propriety and humanity. A Non-commissioned officer or soldier is confined in charge of a guard; but, by the custom of the service, the Non-commissioned Staff and Sergeants may be simply arrested. The Articles of War declare "that no officer or soldier who shall be put in arrest or imprisonment shall continue in his confinement more than eight days, or until such time as a Court-Martial can be conveniently assembled." The latter part of this clause evidently allows a latitude which is capable of being abused; but, as in a free country there is no wrong without a remedy, an action might be brought against the offender in a Civil Court, if the mode of redress for all officers and soldiers who conceive themselves injured by their Commanding Officer be not sufficient.

It is declared by the Articles of War that "no officer commanding a guard, or Provost-marshal, shall refuse to receive or keep any prisoner committed to his charge by any officer belonging to the forces of the United States: provided, the officer committing shall, at the same time, deliver an account in writing, signed by himself, of the crime with which the said prisoner is charged;" and it is also declared that "no officer commanding a guard, or Provost-marshal, shall presume to release any prisoner committed to his charge without proper authority for so doing, nor shall he suffer any person to escape, on the penalty of being punished for it by the sentence of a Court-Martial. Every officer or Provost-marshal to whose charge prisoners shall be committed shall, within twenty-four hours after such commitment, or as soon as he shall be relieved from his guard, make report in writing, to the Commanding Officer, of their names, their crimes, and the names of the officers who committed them, on the penalty of being punished for disobedience or neglect, at the discretion of a Court-Martial." Thus the liberty of the citizen under military law, so far as is consistent with the ends of justice, seems to be guarded with precautions little inferior to those which secure personal liberty under the civil laws of the State. The penalty of an officer's breaking his arrest, or leaving his confinement before he is set at liberty by his Commanding Officer, or by a Superior Officer, is declared to be cashiering by sentence of a General Court-Martial. A Court-Martial has no control over the nature of the arrest of a prisoner, except as to his personal freedom in Court; the Court cannot, even to facilitate his defense, interfere to cause a close arrest to be enlarged. The officer in command is alone responsible for the prisoners under his charge. Individuals placed in arrest may be released, without being brought before a Court-Martial, by the authority ordering the arrest or by superior authority. It is not obligatory on the Commander to place an officer in arrest on application to that effect from an officer under his command. He will exercise a sound discretion on the subject. But in all applications for redress of supposed grievances inflicted by a Superior it will be his duty, in case he shall not deem it proper to order an investigation, to give his reasons, in writing, for declining to act; these reasons, if not satisfactory, the complaining party may, should he think fit so to do, forward to the next Common Superior, together with a copy of his application for redress. An officer has no right to demand a Court-Martial, either on himself or on others; the General-in-Chief or officer competent to order a Court being the judge of its necessity or propriety. Nor has any officer who may have been placed in arrest any right to demand a trial, or to persist in considering himself under arrest, after he shall have been released by proper authority. An officer under arrest will not make a visit of etiquette to the Commanding Officer or other Superior Officer, or call on him, unless sent for; and in case of business, he will make known his object in writing. It is considered indecorous in an officer in arrest to appear at public places.

ARRICK PROJECTILE.—This projectile consists of a cast-iron body having a conical base, to which is attached a sabot combined of an annular key and a concave and convex disk. Upon discharge, the ring is flattened out against the base of the projectile, and



Arrick Projectile.

takes the impression of the grooves, communicating rotation to the projectile; at the same time the annular key is driven forward upon the base, filling the space between the projectile and the lands, and is claimed to center the base of the projectile. The sabot is prevented from turning on the projectile by a series of flanges cast on the base, which fit into recesses on the sabot, and from stripping by means of a strong bolt screwed into the base of the shot. See *Expanding Projectiles.*

ARROW.—1. In fortification, a work placed at the salient angles of the glacis, communicating with the covered-way. 2. A missile weapon of defense, straight, slender, pointed, and barbed, to be shot with a bow. See *Archers.*

ARROW-POISONS.—The ingredients selected for the preparation of toxic compounds vary greatly in different localities, vegetal poisons predominating in the warmer regions, while the organic are preferred in the colder latitudes. This is attributable to the fact that poisonous plants are scarce in the northern portions of the continents, and that organic poisons deteriorate rapidly in the tropics. There are numerous instances also in which the alleged poison is of the most harmless nature, the belief in its potency being based mainly upon the amount of dancing and deviltry performed by an awe-inspiring Shaman. The first group, to which reference will be made, consists of three poisons prepared by the Moqui of Arizona. The first of these is called Ti-ki le-li-wi—poison-ointment. Poison given internally to cause death, whether in powder or liquid, has no definite name beyond its being "bad medicine." The "poison-ointment" is prepared in this wise: A rattlesnake is tormented until it bites itself, when the Priest of the "Snake Order" dips the arrow-point, as well as a short portion of the shaft, into the blood obtained from the serpent. It is stated that a wound from such an arrow will cause death in from three to four days under ordinary circumstances, and in a much shorter time if the victim has been fasting for a day or two, a condition in which an Indian is frequently found even in times of peace. The second variety is prepared from the humble-bee, which, after being maddened by being disturbed in the nest and struck at by withes and branches, is killed. The insects are then gathered and crushed in a primitive stone mortar, where the mass is thoroughly macerated, after which the arrows are anointed in a manner similar to the preceding. Wounds are not liable to cause dangerous results, although they become exceedingly inflamed and very painful, the effects being attributable to the presence of formic acid. The third variety is prepared by crushing a number of large red ants—a variety found all over the northern elevated areas—in a similar manner as the preceding, and in which the arrows are dipped. This poison is not necessarily a fatal one, though instances have been given on "Indian authority." The Indians state that if a man be wounded with an arrow freshly poisoned he will be debilitated (after the first symptoms of excitement are over), from which he may not recover for several weeks or perhaps a month. The last two substance may be prepared by any one of the tribe, as they are used in hunting, but the first named is prepared only, as has been stated, by the Priest of The Snake Order, and is used in warfare with neighboring Indians only. The Apaches, occupying the habitable areas of Arizona, immediately south of the Moqui Pueblos, prepare a poison composed of the venom of the rattlesnake mixed with the decomposed liver of a deer or antelope. A rattlesnake is searched for at one of the prarie-dog towns, and when discovered is secured to the ground by means of a forked stick so as to prevent its escape and yet not to injure it. An assistant then pierces a deer's liver, which has been procured for the purpose, and upon inserting a short pole, thrusts it toward the serpent, who repeatedly buries its fangs. In this manner the venom is secured, and when the snake refuses to bite again it is destroyed. The liver is then placed upon a tall, upright pole, where it is allowed to decompose, after which it is crushed in a small dish, when the arrows are dipped into the mass and allowed to dry. Poisoned arrows are carried in double quivers, and tied together with a black band or piece of cloth to distinguish them from harmless ones. Serpent-venom is employed by the Siris of western Sonora. After a small excavation has been made in the ground a cow's liver is introduced together with centipedes, scorpions, and a rattlesnake. After teasing these creatures for a while with the hope that the liver might receive most of the venom discharged during their angry struggles, it is removed and crushed into a jelly, into which the arrows are dipped.

Apache arrows which have been properly besmeared with poison are readily distinguished from the ordinary weapons by the dark reddish-brown coating over the anterior portion of the shaft immediately back of the arrow-head. The latter also presents the same appearance at times, though were this the only portion to which poison had been applied there would be difficulty in identification, as the arrow-points are generally secured to the end of the shaft by the liberal application of mesquite-gum, after which the sinew-threads are applied for greater security. The Shoshone and Bannock Indians of western Nevada prepare poison in the following manner: An antelope or a deer is entrapped or caught by wounding it, when a rattlesnake is brought and made to bite it. The animal is immediately killed and the blood collected in a vessel procured for the purpose. Into this the arrows are dipped and afterward allowed to dry, when they are ready for use. It is probable that the snake-venom exerts no influence in this instance, as the amount absorbed into the system of the animal between the moments of being bitten and killed would be very slight indeed. The Pah-Utes, just south of the Shoshones, remove the heart of a large mammal and place it into a corresponding cavity in the ground. Rattlesnake-fangs, with the poison-sacs, are then ground into a pulp, with a horned toad or two, which mass is then emptied into the cavity of the heart and allowed to decompose. The whole mass is said to dry into a tough mass resembling caoutchouc. This is finally cut into small pieces. In poisons prepared by the combination of serpent-venom and decomposed organic matter it is not positively known which, if not both, of the substances acts as the toxic agent. Cases thus far observed or recorded have resulted in septicæmia and death. One in particular, a mere scratch upon the shoulder-blade, died in great misery in less than a week, though not before the flesh had literally dropped from the back as far down as the hips. It is probable that the septic poison of the organic matter remains active for a greater period of time than the serpent-venom, being favored by immediate drying in the drier atmosphere of the extreme western plateaus. Dr. S. Wier Mitchell's experiments do not demonstrate to what length of time serpent-venom may be kept in a dried state and retain its virulence. The active principle (crotaline) may remain active under favorable conditions for an indefinite length of time, but then the symptoms would be exhibited in a manner strikingly similar to those after a fresh wound inflicted by the serpent, which thus far has not been observed. Professor F. V. Hayden and Colonel James Stevenson have both observed the Blackfeet and Assiniboine Indians procure the pure serpent-venom by causing a secured snake to bite a clean piece of bark. The arrows were applied directly to this without the admixture of any other substances. Curious superstitions exist in connection with this strange custom among various tribes. An intelligent Sisseton Dakota states that his father had been a great Shaman in his time and knew all the "secrets of the plants." He had a poison which, if rubbed upon a bullet, would cause the bullet to strike the desired object if the gun was merely held in the direction without regard to accurate aim. Though, if the hunter had once raised his weapon and failed to shoot, the bullet would be worthless unless again handed to the Shaman. Another mode of preparing bullets was by drilling small holes into them with the point of a knife, into which was spread a paste made of the bark-scrapings of the cactus (*Opuntia Missouriense*). The Pitt River Indians prepare, at times, a mixture of the juice of the wild parsnip and the decomposed liver of a dead dog. This is also practiced by neighboring tribes in California, although the custom appears to have originated with the former, as far as can be ascertained at this day. Among the southern Esquimaux the body of a dead whaler is cut into small pieces and distributed among his friends who are of the same profession, each of whom, after rubbing the point of his lance upon it, dries and preserves his piece as a sort of talisman. The Kiatera-mut, a tribe of the same stock, believe that to be successful in whale-hunting the body of a whaler must be procured by murdering him, when the fatty portions are removed from the body and boiled, carefully skimming off such fragments as may form a scum, which are then allowed to become putrid. The points of the weapons are greased with this substance, which is considered to give them unfailing success in hunting, both afloat and on shore. Numerous substances of a questionable character are found in all tribes, but their efficacy, in the cases for which they are recommended, can never be ascertained, as an Indian will not admit a failure so long as he can escape detection.

ARROW-WOOD.—A species of *Viburnum*, from the long straight stems of which the Indians dwelling between the Mississippi and the Pacific make their arrows.

ARSENAL.—The name given to a great military or naval repository, where the munitions of war are to some extent manufactured, but more particularly stored until required for use. Every dockyard, every magazine, every armory, is to some extent an Arsenal; and therefore the meaning of the word is not quite definite. In France, the chief Arsenals are at Cherbourg, Brest, and Toulon. In England, although Deptford is a considerable storehouse for naval clothing and provisions, and Weedon and the Tower great repositories for military stores, the only establishment vast enough to deserve the name of Arsenal is at Woolwich. This is truly a remarkable and important place. In the spring of 1859, when war was raging in Italy between the French and Sardinians on one side, and the Austrians on the other, and when an uneasy feeling pervaded the whole country, there were for a short time more than 10,000 men employed in Woolwich Arsenal. There were at that time nearly 12,000 pieces of iron ordnance in store, of which 7000 were of modern make and of heavy caliber. This store was supplementary to that which is always kept at the dockyards of Woolwich, Chatham, Sheerness, Portsmouth, Plymouth, and Pembroke. There were resources at the Arsenal for bringing forward, fitting, and issuing these reserve guns at the rate of 200 per week, or double this number on an emergency; and many hundreds were within a brief period shipped thence, to strengthen the forts in the Mediterranean, in the Colonies, and around the coasts. All the shot and shell used down to the period of the Crimean War were ordered of private makers; but the charge was so enormous during the early months of that war that the government resolved to try the manufacture at Woolwich; this was done, with a very manifest saving of expense. It has been calculated that the Arsenal, when at full work, could produce large shot and shell with six times the rapidity with which those missiles were used by the British outside Sebastopol during the eleven months' siege. These observations do not apply to rifles or muskets; none of these weapons are made at Woolwich. There have been times, however, during the year 1859, when nearly a *hundred million* rifle-bullets were in store at the Arsenal. The Arsenal is divided into two great sections, of which the one is the depot for the storage of arms and all military equipments, whether for land or naval service; the other being occupied by the manufacturing departments. The latter comprise the Gun Factories, where all cannon are made; the Carriage Departments, for gun-carriages and all means of transport; and the Laboratory, whence come all cartridges, shot, shell, bullets, and warlike weapons.

In the United States, Armories and Arsenals were not established until after the Revolutionary War; but powder was manufactured in Virginia in 1776. General Washington chose Springfield, Mass., in 1777, as a suitable location for an Arsenal, and small-arms were manufactured before 1787; an Arsenal was also built in Carlisle, Pa., about the same time. The erection of an Armory was begun at Harper's Ferry in 1795, and Congress ordered three or four more to be built in the same year, still more in 1808, and again after the War of 1812, Congress adopted the plan of having an Arsenal in each State. In 1847 the United States had 2 Armories and 17 Arsenals; in 1860, 23 in all, 9 of which were enlarged during our Civil War, the Springfield Armory alone having capacity to complete 1000 muskets per day. The late General Rodman, in connection with the Ordnance Department, made great improvements in the art of casting cannon cooled from within, and the introduction of mammoth grain powder for use in large guns is due to him. Recently it has been decided to concentrate all manufacture of arms in three or four places, where all the regular operations are to be carried on.

The Arsenals and Armories now established are as follows, to wit: Benicia Arsenal, Benicia, Cal.; Kennebec Arsenal, Augusta, Me.; Watertown Arsenal, Watertown, Mass.; Fort Union Arsenal, N. M.; Springfield Armory, Springfield, Mass.; Watervliet Arsenal, West Troy, N. Y.; Indianapolis Arsenal, Ind.; New York Arsenal, Governor's Island, New York Harbor; Pikesville Arsenal, Pikesville, Md.; Rock Island Arsenal, Ill.; Frankford Arsenal, Philadelphia, Pa.; San Antonio Arsenal, Tex.; Washington Arsenal, Washintgon, D. C.; Fort Monroe Arsenal, Old Point Comfort, Va.; Augusta Arsenal, Augusta, Ga.; Jefferson Barracks Arsenal, Mo.; Vancouver Arsenal, Vancouver, W. T.; Allegheny Arsenal, Pittsburg, Pa.

The principal manufacturing operations of the Ordnance Department are now performed at the following Arsenals, to wit: Watertown, engaged in the production of sea-coast carriages and projectiles for heavy guns; Springfield Armory, in the manufacture of small-arms; Watervliet, in the manufacture of leather-work; Frankford Arsenal, in small-arm ammunition; and Fort Monroe Arsenal, in sea-coast carriages and on experimental duties. The remaining Arsenals are either engaged in small repairs or are simply storage-depots for the care and preservation, issue and receipt, of ordnance and ordnance-stores. It is believed that, except small-arms and small-arm ammunition, the more important ordnance and ordnance-stores, more especially those for field and siege artillery, and those to be provided for the use of our sea-coast defenses, such as cannon, heavy sea-coast carriages, projectiles, and ammunition, and other stores and appliances for their service and maneuver, also harness and the more elaborate articles of leather-work, should all be made at one grand Arsenal of Construction. See *Armory*.

ARSENIC.—The name applied in popular language to a well-known poisonous substance, arsenious acid; but, strictly speaking, the term is restricted to the metal, of which the symbol is As and the equivalent is 75.0. The metal arsenic is rarely found free in nature, but in a state of combination it occurs largely. The metal is generally prepared from arsenious acid (AsO_3) by mixing it with its own weight of charcoal, placing the mixture in a well-covered crucible, and subjecting the whole to heat, when the metal set free by the charcoal rises, and condenses in the upper part or cover of the crucible. Metallic arsenic is very brittle, can easily be reduced to powder by hammering, or even pounding in a mortar; and when a freshly-cut surface is examined, it presents a brilliant dark steel-gray luster, which, however, readily tarnishes on exposure to the air. The metal, as such, is not considered poisonous; but when introduced into the animal system, it is there faintly acted upon by the juices, and in part dissolved, at the same time exhibiting poisonous properties. When heated in the open air, it burns with a peculiar bluish flame, and emits a characteristic alliaceous odor. The only use to which the metal arsenic is applied in the arts is in the manufacture of leaden shot of the various sizes, when its presence in small quantity in the lead renders the latter much more brittle than it ordinarily is. Of all the compounds of arsenic the most important is the one already alluded to, viz., arsenious acid, which is an oxide of arsenic. With sulphur, arsenic forms two important compounds: *realgar* (AsS_2), a red, transparent, and brittle substance, which is employed in the manufacture of the signal-light called *White Indian Fire;* and *orpiment* (AsS_3) or *king's yellow*, a cheap pigment of a yellow color. With hydrogen, arsenic forms arseniuretted hydrogen (AsH_3), a very poisonous gas.

ARTESIAN WELLS.—The Artesian Well so frequently sunk by the Military Engineer has of late been the subject of several special reports from the office of the Chief of Ordnance, United States Army. Usually they are perpendicular borings into the ground, through which water rises, from various depths, according to circumstances, above the surface of the soil. The possibility of obtaining water in this way in a particular district depends on its geological structure. All rocks contain more or less water. Arenaceous rocks receive water mechanically, and according to their compactness and purity part with a larger or smaller proportion of it. A cubic yard of pure sea-sand can contain, in addition to the quantity of dry sand which occupies that space, about one third of its bulk of water. It would part with nearly the whole of this into a well sunk in it, and regularly pumped from. Chalk and other rocks, composed of fine particles, closely compacted together, contain as large a proportion of water. From the existence, however, of numerous crevices in chalk through which the water freely flows, and from the general presence of a larger quantity of water than the porous rock is able to retain, wells sunk in chalk often yield water. There is yet a third class of rocks, which are perfectly impervious to water: such are clays, which are absolutely retentive, neither allowing water to be obtained from them nor to pass through them. When such rocks occur in basins in alternating layers, and in such order that pervious beds are inserted between impervious ones, it is evident that if a perforation is made through the retentive barrier-bed in the lower portion of the basin, the water contained in the water-logged strata will rise through the bore to a height depending upon the pressure of water which has accumulated in the confined sloping space between the two impervious beds. There is a number of porous beds composing the cretaceous measures, resting on the impervious gault, and these, again, are covered by the equally impervious series of the London clay, which form the strata on the surface, and extend to a considerable depth. The edges of the chalk-beds are largely exposed in the higher grounds around London; the water falling on the whole area of these exposed edges, sinks into the more or less porous cretaceous beds, and would, in course of time, by continued accessions, fill up the basin, were it not prevented by the clay above. By driving a bore through this superior bed, the inferior water-logged strata are reached, and the subterranean water rises to the surface, and flows continuously, by means of hydrostatic pressure. Many such Wells exist in London and its vicinity; those which form the ornamental fountains in Trafalgar Square descend into the upper chalk to a depth of 393 feet. The most famous Artesian Well, perhaps, is that of Grenelle, in the outskirts of Paris, where the water is brought from the gault at a depth of 1798 feet.

In California, Colorado, Idaho, and other Western States, wells are largely used for irrigation, and for supplying water at Military Posts, inasmuch as there are no rains, during certain seasons, in those localities. There are over 1000 of these wells in California alone, most of which are flowing. Since 1855, there have been 76 flowing wells sunk in the Desert of Sahara, Africa, yielding over 13,000,000 gallons of water daily. Since then, a beautiful oasis has been formed around each well, literally "making the desert to blossom as a rose."

In 1851 London had Artesian Wells that supplied over 12,000,000 gallons of water daily. The well at Trafalgar Square, 393 feet deep, is said to yield 600,000 gallons of water per day. One at the Government Works in Orange Street yields a larger amount. Hughes writes that a well at Woolwich, 580 feet deep, yields 1,400,000 imperial gallons in 24 hours, and another near London, only 171 feet deep, yields nearly 2,500,000 gallons per day. Wells in the county of Kent, near London, in 1867 furnished 7,000,000 gallons per day, which was distributed to 34,504 houses with a population of 240,000. In the year 1854, the "Bootle Well" in Liverpool yielded 1,100,000 gallons in 24 hours.

The following is a synopsis of a few of the most noted deep wells:

Wells.	Finished.	Depth in feet.	Capacity gallons per day.
Grenelle. Paris	1841	1,792	500,000
Passey, France	1860	2,000	5,660,000
Kissengen, Bavaria	1850	1,878½	1,077,000
Spermberg, Prussia		4,170	
Belcher's Sugar-house. St. Louis		2,199	108,000
Insane Asylum, St. Louis		3,843½	
Louisville, Kentucky		2,066	330,000
Terre Haute, Indiana		1,900	
Near Lake Charles, Louisiana		440	93,600
Columbus, Ohio		2,775½	
Charleston, South Carolina		1,250	
New Orleans, Louisiana		630	
United States Mint, Philadelphia		458	90,000
Continental Hotel, Philadelphia.		206	72,000
City of Waukegan, Illinois	1875	1,110	300,000
National Rubber Co., Bristol R. I.	1880	35	300,000

The Pierce Well-Excavator Company, New York, are the contractors with the United States Government, and are at present sinking a deep well at David's Island, New York Harbor. After noticing the important details of the well-boring machinery, we will briefly describe the manner in which this Company drills an Artesian Well. Before designing and introducing their highly improved machinery, Artesian Wells in this country were sunk with what is termed walking-beam machines—that is, such machines as have been and are now used in the oil regions of Pennsylvania for drilling oil-wells. Such an apparatus weighs from 15 to 20 tons. The derrick is usually built 72 feet high. An engine and boiler of about 15 to 20 horse-power is required to operate such a machine. The derrick must be built and taken down for every well. Setting up a walking-beam machine and getting ready to work requires the labor of four men from two to three weeks to build the tower, set the engine and boiler, and get ready for work.

In the following drawing, Fig. 1 shows a *rope-socket* of a new pattern. A double reamer is sometimes used with the drilling-machine, for straightening crooked holes, but the *reamer* shown in Fig. 2 is most commonly used for trimming a flat hole and making it round and straight. Fig. 3 represents a *wedge* or *club bit*, also used for drilling hard rock. The *Z-bit*, Fig. 4, is a combined wedge bit, reamer and double reamer, and with it all the different kinds

Fig. 1.

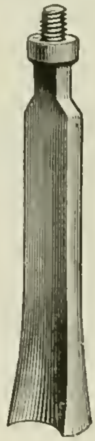


Fig. 2.

Fig. 3.

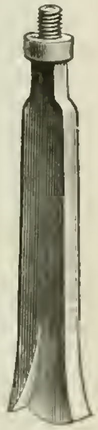


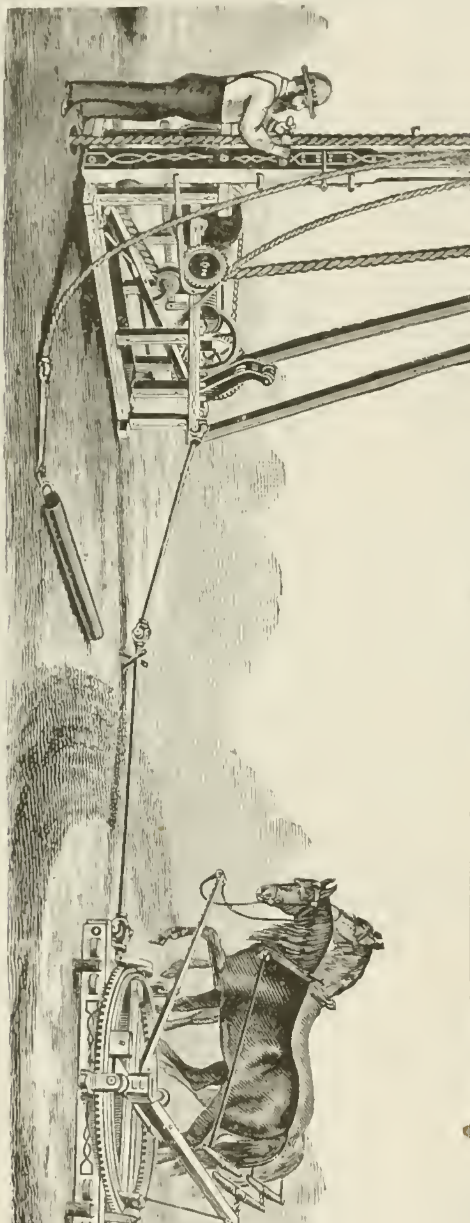
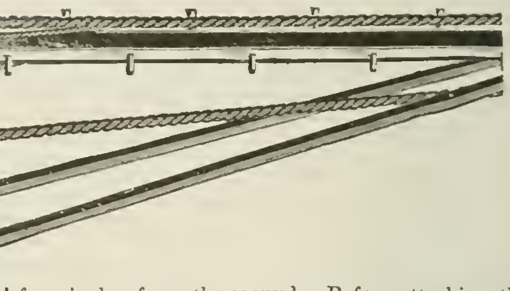
Fig. 4.

of work can be done, i.e., drilling rock, earth or sand, and crooked or flat holes can be made straight and round with it. The rods break in drilling, and for raising the portions broken off various ingenious devices, known as *slip-sockets*, *horn-sockets*, *pin-sockets*, *grabs*, *rope-spears*, *rope-knives*, *rope-grabs*, *boot-jacks*, etc., have been contrived. The *slip-socket*, shown in Fig. 5, and the *grabs*, shown in Fig. 6, are most commonly used as fishing-tools for recovering bits, drilling-tools, bars of iron, or other things that might accidentally or carelessly be dropped or lost in the drilled hole. The success of an Artesian Well depends much upon the proper selection of pipe for the well-tubing. Heavy lap-welded wrought-iron pipe, $\frac{5}{16}$ inch thick, with screw and collar connections, is best adapted to Artesian Well work. This pipe is used to drive through sand, clay, or other earth formations until solid rock is reached; the drilling is then continued in the rock, no pipe being required. All other pipe, usually $\frac{1}{4}$ inch thick, is used for casing wells after they have been drilled to the required depth and it is necessary to case off salt or mineral waters. Fig. 7. shows a cement or terra-cotta pipe or tile that is used in bored wells. These pipes are one to two inches thick, and can be had in almost all countries from 2 to 30 inches in diameter. For bored wells 8 to 12 inches internal diameter is preferable. The joints can be made water-tight by using hydraulic cement, and by this means brackish or surface water and foul drainage can be entirely avoided, which is of vast importance in most places, often preventing sickness and many fatal diseases. Fig. 8 represents a style of punched, rolled and fitted sheets of iron, that can be used to advantage for well-casing, water-pipes, and many other purposes. This is a desirable style when transportation is an object, as the piping can, in all sizes of common or galvanized iron, be

Fig. 5.

Fig. 6.

nested and packed very close, in rolls weighing from 100 to 300 pounds, and fitted either with flange, sleeve and nipple, or lug slip joints. When it is desired to use wood casing for drilled wells it is well to make the strips quite narrow, and if the casing is to be driven very hard it will facilitate the work by putting a hoop around the bottom or making a sheet-iron band, 4 or 6 inches wide, and riveting it around the bottom section to prevent jamming or spreading.

Drilling an Artesian Well—Pierce Well-Excavator Company.

In drilling the well, we will suppose the earth above the rock to equal or exceed 50 feet. Having located the site, set the drill-jack and horse-power in position, as shown in the accompanying engraving. The horse-power may be used on either side of the jack. Care must be taken to set the drill-jack so that when the drill, etc., are hung up on the machine they will hang parallel with the mast. Use the longest piece of tumbling rod on the ground next to the horse-power. This can be laid over two stakes driven in the ground crosswise, thus: ×, or on a block of wood near the center joint. This lies about four inches from the ground. Before attaching the horses the bull-wheel should be turned over with the cogs upward, and every cog on the large bull-wheel ring should be rubbed full of soft tallow or common axle-grease. Stake the horse-power down very firm and solid, attach the horses to the horse-power, and walk them around it for half an hour, or until they get accustomed to the motion of the power and to walking in a circle. Next attach the tumbling-rods, start the horses very slow and steady until they get used to the revolving of the tumbling-rods and the main shaft of the machine, then pass the drill-rope from the spool down under the roller at the foot of the mast, then through the pulley of the drill-lever, then over the top of mast-pulley and down to the ground. Screw the Z-bit into the auger-stem, to which

Fig. 7.

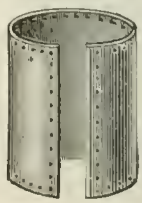


Fig. 8.

also screw the rope-socket, tie the end of the rope very securely into the rope-socket, place the crank on the ratchet-wheel shaft, and wind the tools up so they will swing above the ground. Oil every pulley, journal, or bearing about the machine, where there is any friction; also every link in the winding-chain. The pulley in the mast-head and the pinion-wheels of the horse-power should be well oiled every two or three hours. When the well is to be drilled through earth, throw out about one foot in depth with a shovel. If the ground is frozen this can be done with a drill, the same as if rock. Throw two buckets of water in the hole. Put the swiveled pulley on the drill-lever at the hole nearest to the front of the machine, so as to get the shortest stroke in starting. Let the horses walk around slowly and steadily at first, then push the lever-catch shifter at the left-hand side of the bottom of the machine. This will release the drill-lever, and the drill will work up and down.

The man in charge of the machine must turn the drill around about one fifth of a revolution every stroke. As the drill chops the clay or earth, and mixes it into the consistency of mush or soft mud, the drill can be lowered gradually by raising the pawl of the ratchet-wheel. Let the ratchet-wheel move one notch at a time, as one notch of the ratchet-wheel allows the drill to settle about an eighth of an inch. After the drill has worked down about two feet, the lever-catch shifter at the left-hand side of the machine is then raised and drawn forward with the left foot. This causes the catch to hold the drill-lever down, and the churning motion of the drill is stopped. Then throw the clutch-lever (on the left-hand side of the jack) outward from the machine; this throws the clutch in gear, and the drilling-tools are raised from the well. When the tools are raised to a proper height and out of the hole, throw the clutch out and let a sand-pump down to the bottom of the hole, and churn up and down very quickly, about four inches, twenty times. This will fill the sand-pump. Then bear down on the belt-tightener and the machine will raise the sand-pump out. Repeat this two or three times, then throw in two more buckets of water. Let the drill down in the hole by raising the pawl of the ratchet-wheel up hard against the rim of the ratchet-wheel, to let the ratchet-wheel turn by friction against the arm of the pawl. This lets the drill down to the bottom of the hole. Then continue the churning of the drill as before. Every time the hole is sand-pumped more water should be thrown in. After a depth of ten feet is drilled, four feet in depth of water may be kept in the hole.

The drilling may be continued in this manner until the rock, gravel, or quicksand is reached. If the latter fills the hole as fast as taken out, a tube can be made out of boards 6 inches in diameter for very short distances, or piping can be used, where the depth of gravel, etc., above the rock is more than 25 feet. This is placed in the drilled hole, and driven down through the stratum of sand or gravel by using the auger-stem (or drill-rod) for a driver. A hole 7 or 8 inches in diameter can be easily drilled in earth with a 6-inch Z-bit, by using plenty of water and swaying the drill-rope a little each way as the drill makes its downward stroke. When the rock is reached the hole can be cleaned out with the sand-pump, and the hole is of proper size to guide the tools in drilling the rock. The drilling can then be continued to any required depth, care being taken to keep the bit an eighth of an inch smaller than the internal diameter of the pipe. The process of drilling in solid rock is very simple, care only being taken to keep the drill-bit full size, not feeding the drill down too fast, keeping the rope tight, and drilling on what is called the "spring of the rope," thus making a straight hole. Have 3 to 6 feet of water in the hole while drilling, turn the drill six to eight times in one direction, about one fifth of a revolution each stroke, then backward to cause the drill to cut a round hole.

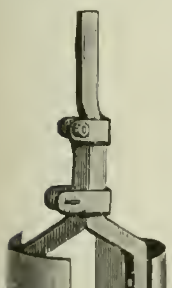


Fig. 9.

In drilling wells for water, where 5 to 10 barrels of water per day is required, it is usually necessary to continue the drilling until there is from 10 to 20 feet of water in the drilled hole. If 50 or 100 barrels of water per day is needed, usually a depth of 30 or 40 feet of water will furnish the required amount. The capacity of the well can be tested with the machine any time by the use of the sand-pump, as it can be filled and emptied three to four times per minute; it holds from three to five gallons of water, and a continued use of same for one or two hours will show the capacity of well. If it runs into the well as fast as taken out, it will not be necessary to continue the drilling any farther. For prospecting for mineral, oil, or coal, the drilling may be continued if there should be 100 to 500 feet of water in the hole. The drilling is done the same as if there was no water, with the advantage that it is not necessary to throw any in the hole. The sand-pump works the same in a great depth of water as it would if there was but 6 feet of water. If it is desired or necessary to make the well as economically as possible, pipe can be used, made of sheet-iron about $\frac{1}{16}$ inch in thickness, a half-inch smaller than the drilled hole. This usually costs, or can be made, for 20 cents or 30 cents per foot. This pipe is used by placing it in the hole, so the bottom end of it will come about 4 feet below the bottom of the heavy pipe that was first used. If it is necessary to shut off sand, the bottom end of this pipe may be flanged outward a little, and a few buckets of cement thrown down outside of the pipe, which settles around the pipe above the flange, and the result is that a water-tight connection is made with the rock. This effectually shuts off all surface-water or sand. The drilling can be commenced in the bottom of an old well, without removing the stones, or interfering with the walls, or getting into the well, in which case a common square wood box, 6 inches inside, can be used in the bottom of an old well for a guide to start the tools straight. If this machine is used, it is not advisable to use an excavator or boring tools in earth above the rock, as this machine will drill in earth as rapidly as boring can be done with the excavator or borer.

An enlarged view of the well-auger invented and used by the Pierce Well-Excavator Company is shown in Fig. 9. The most practical size is 12 to 17 inches in diameter, and with reamer attachment will bore a 24- to 36-inch hole. The peculiar shape and construction of this patent borer enables it to bore through frozen ground, hard-pan, or slate, as well as clay and gravel. Side-draught is impossible. The cutters penetrate with a draw-cut, making a straight hole. The outer corners of the cutters being farthest from the center, no friction can come upon the sides of the borer. The pods or barrel of the auger being 2 inches less in diameter than the cutters, air and water pass behind them, avoiding suction when raising the borer from the well. This borer has all the combined advantages of a clay- and boulder-auger, as it will take up stones half as large as the diameter of the hole, and wells can be put in without the aid of other tools or attachments for boring. All of the above points are essential in a successful well-boring tool. Before the invention of these augers, borers were made for the same purpose, constructed in such a manner that when filled with earth the hole was entirely filled, and they could not be withdrawn without great suction, as the air and water could not pass below the auger when withdrawing it from the hole. Pipes and tubes have been used for air-passages in earth-borers, but they were failures, as they became clogged with mud. See *Well-boring.*

ARTICLES OF WAR.—There can be no doubt that the prerogative to command and regulate the whole military force of the kingdom, whether consisting of the feudal tenants, or of the militia, or of paid troops, resided in the Crown of England. Nevertheless the power of the Sovereign was restricted by a provision that he should exercise his military jurisdiction only "according to the laws and usages of the realm." In the reign of Edward VI., however, Parliament asserted authority over military matters by passing an act for the government of the army; various offenses, as losing, selling, or fraudulently exchanging horses or armor; desertion; detaining the pay of soldiers; and taking rewards for granting them discharges, were put under the jurisdiction of the Civil Magistrate. It was also provided that the Act should be read once a month by every Field-Officer to the soldiers under his command, and once a quarter by the Governor or Captain of every garrison or fortress. At this period, however, there was no standing army, the feudal system was still in force, every man in the realm was more or less a soldier; military law was accordingly restricted to such persons as were actually serving in the field, the process of civil judicature being obviously inapplicable to their case—but directly the soldier ceased to belong to the force in actual campaign, the civil power stepped in and claimed cognizance of his offenses.

Until the Civil War in the reign of Charles I., it is probable that no regular permanent Code of Rules or Articles for enforcing military discipline was in existence; the ruling authority had promulgated its orders for the government and regulation of the army as occasion required. Each war, each expedition, had its own edict, which fell into disuse again upon the disbanding of the army, which inevitably followed the cessation of hostilities. The experience of ages and the precedents of former wars, therefore, enabled the authorities to frame a sufficiently comprehensive code in case of need; accordingly, soon after the outbreak of the Civil War, the necessities of the case compelled the Parliament to enact Ordinances or Articles of War. The first complete "*Lawes and Ordinances of Warre*" (as he called them) were issued by Essex, the Commander-in-Chief of the Parliamentary Army in 1642. These Articles are remarkable and interesting, as undoubtedly forming the groundwork of those now in use. Two years after the publication of Essex's Ordinances, on the marching of the Scottish army into England, soon after the ratification of the solemn league and covenant, "Articles of War" were issued for its government. These Articles, although very dissimilar to those of Essex, considering that both were in force in the same kingdom at the same time, and were applicable to armies fighting on the same side, nevertheless treat mainly of the same offenses. The form of judicature established consisted of two Courts of Justice, called "Councils of War," the one superior and the other inferior. The Superior Court, also called the "Court of War," took cognizance of the more serious offenses, and likewise heard appeals from the decision of the Lower Court, called the "Martial Court." No trace of the constitution of these Courts is now to be found except that "the Judges were sworn to do justice." Within a few months of the promulgation of the latter (August, 1644), the same Parliament that was the author of the petition of right passed an ordinance establishing a system of martial law, applicable not only to soldiers, but to all persons alike. By this Ordinance, the Earl of Essex, Captain-General of the parliamentary forces, together with fifty-six others named therein (among whom were peers, members of the House of Commons, gentry, and officers of the army), were constituted "Commissioners," and any twelve of them authorized to hear and determine all such causes as "belong to military cognizance," according to the Articles mentioned in the Ordinance, and to proceed to the trial, condemnation, and execution of all offenders against the said Articles, and to inflict upon them such punishment, either by death or otherwise, *corporally*, as the said Commissioners, or the major part of them then present, should judge to appertain to justice, according to the measure of the offense. Under cover of this ordinance, which, after one refusal by the peers, was subsequently renewed, Parliament proceeded to issue a variety of orders for the conduct of the war and the regulation of the army; and many persons were tried by Court-Martial and executed. After the expiration of this last ordinance, the absolute executive power, in all matters of military law, fell into the hands of Cromwell, who claimed it as his right, in virtue of his office of General-in-Chief. "The General," says Whitlocke, "sent his order to several garrisons to hold Courts Martial for the punishment of soldiers offending against the Articles of War; provided that if any be sentenced to lose life or limb, then they transmit to the Judge-Advocate the examinations and proceedings of the Court-Martial, that the *General's* pleasure may be known thereon." On one occasion, deeming it necessary, for the sake of discipline, to make an immediate example, Cromwell seized several officers with his own hand, called a Court-Martial on the field, condemned them to death, and shot one forthwith at the head of his regiment. It will thus be seen that the administration of martial law was almost invariably in the hands of the most considerable power in the State—it alternated between King and Parliament, and between Parliament and Dictator, as each became uppermost in the realm. On the restoration of Charles II., the army, with the exception of about five thousand men, consisting of General Monk's regiment called "the Coldstream," the first regiment of foot, the royal regiment of Horse-Guards, called the "Oxford Blues," and a few other regiments, was disbanded. The force kept on foot was the first permanent military force, or "Standing Army," known in England; and from it the present army dates its origin.

A statute passed in the reign of Charles II., entitled "An Act for ordering the forces in the several counties of this kingdom," recites that, "within all his Majesty's realms and dominions, the sole and supreme power, government, command, and disposition of the militia, and of all forces by sea and land, and of all forts and places of strength is, and by the laws of England ever was, the undoubted right of his Majesty, and his royal predecessors, kings and queens of England." With the exception of some slight encroachment on the part of the Crown, and protests on the part of the Parliament, matters remained in very much the same state till the Revolution, at which period military law assumed a permanent and definite form, as it now exists. The only allusions to the military power of the Crown, in the Bill of Rights, are, "that the raising and keeping of a standing army in time of peace, *without consent of Parliament*, is contrary to law;" and that "subjects, if Protestants, may have arms for their defense, suitable to their condition, and as allowed by law." In the first year, however, of the reign of William and Mary, British regiments, jealous of the supposed preference shown by William for his Dutch troops, mutined at Ipswich. The king suppressed the mutiny with a strong hand, at the same time communicating the event to Parliament. Parliament, anxious to devise means for the convenient application of a code of laws for the regulation and management of the army, and at the same time determined to place a check upon the exercise of the military power of the King, passed, on the 3d April, 1689, for a period of six months only, the first Mutiny Act, the preamble of which is as follows: "Whereas, the raising or keeping a standing army within this kingdome, in time of peace, unlesse it be with the consent of Parlyament, is against law; and whereas it is judged necessary, by their majestyes and this present parlyament that, during this time of warr, severall of the forces which are now on foote should be continued and others raised, for the safety of the kingdome, for the common defence of the Protestant religion, and for the reducing of Ireland. And whereas no man can be prejudged of life or limb, or subjected to any kinde of punishment by martiall law, or in any other manner than by the judgment of his peeres, and according to the knowne and established lawes of this realme; yet, nevertheless, it being requisite for retaining such forces as are or shall be raised during this exigence of affaires in their duty, that an exact discipline be observed; and that soldiers who shall mutiny or stirr up sedition, or who shall desert their majestye's service, be brought to more exemplary and speedy punishment than the usual formes of law will allow." The Act provides for the assembling and constitution of Courts-Martial, for the oath of members, for the punishment of desertion, mutiny, sedition, false musters, etc.; for the regulation of billets; and is ordered to be read at the head of every regiment, troop, or company, at every muster, "that noe soldier may pretend ignorance." No power is, however, reserved to the Sovereign to make Articles of War. This Act was renewed soon after its expiration; and with the exception of about three years only, viz., from 10th April, 1698, to 20th February, 1701, has been annually re-enacted (with many alterations and amendments) ever since.

Under the Constitution of the United States, Congress only can make rules of government and regulation for the land forces, and those rules, commonly called *Articles of War*, were originally borrowed jointly from the English Mutiny Act annually passed by Parliament, and their Articles of War established by the king. The existing Articles for the government of the army of the United States, enacted April 10, 1806, are substantially the same as those originally borrowed July 30, 1775, and enlarged by the old Congress from the same sources, September 20, 1776. The Act consists of but three sections. The first declares: "The following shall be the Rules and Articles by which the *armies* of the United States shall be governed;" and gives one hundred and one articles, all noticed in these pages. Each Article is confined, in express terms, to the persons composing the army. The second section contains the only exception in the cases as follows: "In time of war, all persons *not* citizens of, or owing allegiance to, the United States of America who shall be found lurking, as *spies*, in or about the fortifications or encampments of the armies of the United States, or any of them, shall suffer death, according to the *law and usage of nations*, by sentence of a General Court-Martial." The third section merely repeals the previous Act for governing the army. The Articles of War, therefore, are, and under the Constitution of the United States can be, nothing more than a code for the government and regulation of the army. Or, in other words, within the United States these Articles are "a system of rules superadded to the common law for regulating the citizen in his character of a soldier," and applicable to no other citizens. Beyond the United States another code is essential; for although armies take with them the Rules and Articles of War, and the custom of war in like cases, in a foreign country the soldier must be tried by some tribunal for offenses which at home would be punishable by the ordinary courts of law. It is impossible to subject him to any foreign dominion, and hence, in the absence of rules made by Congress for the government of the army under such circumstances, the will of the Commander of the Troops, *ex necessitate rei*, takes the place of law, and the declaration of his will is called Martial Law. The most casual reader of our Articles of War will be struck by the fact that whereas the Mutiny Act of Great Britain is annually subjected to the supervision of Parliament, and altered or modified according to circumstances, yet the Rules and Articles of War passed in 1806 have remained upon our statute-book from that day to the present without any general revision. Another fact equally important is that while the king of Great Britain not only *commands* but *governs* the British army, and therefore modifies the government of the army at his pleasure, the President of the United States is simply the Commander of our army, under such rules for raising, supporting, governing, and regulating it as Congress may appoint. The necessity of attention to the military establishment on the part of Congress is therefore manifest, and it is most earnestly to be hoped that, in their wisdom, they will, at some early day, fulfill their constitutional obligations of raising, governing, and regulating armies: 1. By establishing a system of recruiting which will bring into the ranks soldiers who will make good officers; 2. By providing that all commissioned officers shall be appointed from enlisted soldiers, or from military academies, and making rules precisely regulating the manner in which such appointments shall be made; 3. In making rules for a system of promotion partly by seniority and partly by merit; 4. In passing other remunerative laws, such as prize-money, field-allowances, indemnification for losses, etc.; 5. In accurately defining the powers, rights, and duties of all officers and soldiers; 6. In providing remedies for wrongs, including appeals to federal civil courts, to determine the true exposition of military laws in dispute; and 7. In revising the penal code, and better adapting it to a system of government which will provide rewards for good conduct, and not simply punishments for bad.

The Armies of the United States are governed by the following Rules and Articles. The word officer, as used therein, is understood to designate commissioned officers; the word soldier is understood to include non-commissioned officers, musicians, artificers, and privates, and other enlisted men, and the convictions mentioned therein are understood to be convictions by Court-Martial.

ARTICLE 1. Every officer now in the Army of the United States shall, within six months from the passing of this Act, and every officer hereafter appointed shall, before he enters upon the duties of his office, subscribe these Rules and Articles.

ART. 2. These Rules and Articles shall be read to every enlisted man at the time of, or within six days after, his enlistment, and he shall thereupon take an oath or affirmation, in the following form: "I, A. B., do solemnly swear (or affirm) that I will bear true faith and allegiance to the United States of America; that I will serve them honestly and faithfully against all their enemies whomsoever; and that I will obey the orders of the President of the United States, and the orders of the officers appointed over me, according to the Rules and Articles of War." This oath may be taken before any commissioned officer of the army.

ART. 3. Every officer who knowingly enlists or musters into the military service any minor over the age of sixteen years without the written consent of his parents or guardians, or any minor under the age of sixteen years, or any insane or intoxicated persons, or any deserter from the military or naval service of the United States, or any person who has been convicted of any infamous criminal offense, shall, upon conviction, be dismissed from the service, or suffer such other punishment as the Court-Martial may direct.

ART. 4. No enlisted man, duly sworn, shall be discharged from the service without a discharge in writing, signed by a field-officer of the regiment to which he belongs, or by the commanding officer when no field-officer is present; and no discharge shall be given to any enlisted man before his term of service has expired, except by order of the President, the Secretary of War, the commanding officer of a department, or by sentence of a General Court-Martial.

ART. 5. Any officer who knowingly musters as a soldier a person who is not a soldier shall be deemed guilty of knowingly making a false muster, and punished accordingly.

ART. 6. Any officer who takes money, or other thing, by way of gratification, on mustering any regiment, troop, battery, or company, or on signing muster-rolls, shall be dismissed from the service, and shall thereby be disabled to hold any office or employment in the service of the United States.

ART. 7. Every officer commanding a regiment, an independent troop, battery, or company, or a garrison, shall, in the beginning of every month, transmit through the proper channels, to the Department of War, an exact return of the same, specifying the names of the officers then absent from their posts, with the reasons for and the time of their absence. And any officer who, through neglect or design, omits to send such returns shall, on conviction thereof, be punished as a Court-Martial may direct.

ART. 8. Every officer who knowingly makes a false return to the Department of War, or to any of his superior officers authorized to call for such returns, of the state of the regiment, troop or company, or garrison under his command; or of the arms, ammunition, clothing, or other stores thereunto belonging, shall, on conviction thereof before a Court-Martial, be cashiered.

Art. 9. All public stores taken from the enemy shall be secured for the service of the United States; and for neglect thereof the commanding officer shall be answerable.

Art. 10. Every officer commanding a troop, battery, or company is charged with the arms, accouterments, ammunition, clothing, or other military stores belonging to his command, and is accountable to his Colonel in case of their being lost, spoiled, or damaged otherwise than by unavoidable accident, or on actual service.

Art. 11. Every officer commanding a regiment, or an independent troop, battery, or company, not in the field, may, when actually quartered with such command, grant furloughs to the enlisted men, in such numbers and for such time as he shall deem consistent with the good of the service. Every officer commanding a regiment, or an independent troop, battery, or company, in the field, may grant furloughs not exceeding thirty days at one time, to five per centum of the enlisted men, for good conduct in the line of duty, but subject to the approval of the commander of the forces of which said enlisted men form a part. Every company officer of a regiment, commanding any troop, battery, or company not in the field, or commanding in any garrison, fort, post, or barrack, may, in the absence of his field-officer, grant furloughs to the enlisted men for a time not exceeding twenty days in six months, and not to more than two persons to be absent at the same time.

Art. 12. At every muster of a regiment, troop, battery, or company, the commanding officer thereof shall give to the mustering officer certificates, signed by himself, stating how long absent officers have been absent and the reasons of their absence. And the commanding officer of every troop, battery, or company shall give like certificates, stating how long absent non-commissioned officers and private soldiers have been absent and the reasons of their absence. Such reasons and time of absence shall be inserted in the muster-rolls opposite the names of the respective absent officers and soldiers, and the certificates, together with the muster-rolls, shall be transmitted by the mustering officer to the Department of War, as speedily as the distance of the place and muster will admit.

Art. 13. Every officer who signs a false certificate relating to the absence or pay of an officer or soldier shall be dismissed from the service.

Art. 14. Any officer who knowingly makes a false muster of man or horse, or who signs, or directs, or allows the signing of any muster-roll knowing the same to contain a false muster, shall, upon proof thereof by two witnesses, before a Court-Martial, be dismissed from the service, and shall thereby be disabled to hold any office or employment in the service of the United States.

Art. 15. Any officer who, willfully or through neglect, suffers to be lost, spoiled, or damaged any military stores belonging to the United States shall make good the loss or damage, and be dismissed from the service.

Art. 16. Any enlisted man who sells, or willfully or through neglect wastes, the ammunition delivered out to him shall be punished as a Court-Martial may direct.

Art. 17. Any soldier who sells or, through neglect, loses or spoils his horse, arms, clothing, or accouterments, shall suffer such stoppages, not exceeding one half of his current pay, as a Court-Martial may deem sufficient for repairing the loss or damage, and shall be punished by confinement or such other corporal punishment as the Court may direct.

Art. 18. Any officer commanding in any garrison, fort, or barracks of the United States who, for his private advantage, lays any duty or imposition upon, or is interested in, the sale of any victuals, liquors, or other necessaries of life brought into such garrison, fort, or barracks for the use of the soldiers, shall be dismissed from the service.

Art. 19. Any officer who uses contemptuous or disrespectful words against the President, the Vice-President, the Congress of the United States, or the Chief Magistrate or legislature of any of the United States in which he is quartered, shall be dismissed from the service, or otherwise punished, as a Court-Martial may direct. Any soldier who so offends shall be punished as a Court-Martial may direct.

Art. 20. Any officer or soldier who behaves himself with disrespect toward his Commanding Officer shall be punished as a Court-Martial may direct.

Art. 21. Any officer or soldier who, on any pretense whatsoever, strikes his Superior Officer, or draws or lifts up any weapon, or offers any violence against him, being in the execution of his office, or disobeys any lawful command of his Superior Officer, shall suffer death, or such other punishment as a Court-Martial may direct.

Art. 22. Any officer or soldier who begins, excites, causes, or joins in any mutiny or sedition, in any troop, battery, company, party, post, detachment, or guard, shall suffer death, or such other punishment as a Court-Martial may direct.

Art. 23. Any officer or soldier who, being present at any mutiny or sedition, does not use his utmost endeavor to suppress the same, or, having knowledge of any intended mutiny or sedition, does not, without delay, give information thereof to his Commanding Officer, shall suffer death, or such other punishment as a Court-Martial may direct.

Art. 24. All officers, of what condition soever, have power to part and quell all quarrels, frays, and disorders, whether among persons belonging to his own or to another corps, regiment, troop, battery, or company, and to order officers into arrest, and non-commissioned officers and soldiers into confinement, who take part in the same, until their proper Superior Officer is acquainted therewith. And whosoever, being so ordered, refuses to obey such officer or non-commissioned officer, or draws a weapon upon him shall be punished as a Court-Martial may direct.

Art. 25. No officer or soldier shall use any reproachful or provoking speeches or gestures to another. Any officer who so offends shall be put in arrest. Any soldier who so offends shall be confined, and required to ask pardon of the party offended, in the presence of his Commanding Officer.

Art. 26. No officer or soldier shall send a challenge to another officer or soldier to fight a duel, or accept a challenge so sent. Any officer who so offends shall be dismissed from the service. Any soldier who so offends shall suffer such corporal punishment as a Court-Martial may direct.

Art. 27. Any officer or non-commissioned officer, commanding a guard, who, knowingly and willingly, suffers any person to go forth to fight a duel, shall be punished as a challenger; and all seconds or promoters of duels, and carriers of challenges to fight duels, shall be deemed principals, and punished accordingly. It shall be the duty of any officer commanding an army, regiment, troop, battery, company, post, or detachment, who knows or has reason to believe that a challenge has been given or accepted by any officer or enlisted man under his command, immediately to arrest the offender and bring him to trial.

Art. 28. Any officer or soldier who upbraids another officer or soldier for refusing a challenge shall himself be punished as a challenger; and all officers and soldiers are hereby discharged from any disgrace or opinion of disadvantage which might arise from their having refused to accept challenges, as they will only have acted in obedience to the law, and have done their duty as good soldiers, who subject themselves to discipline.

Art. 29. Any officer who thinks himself wronged by the commanding officer of his regiment, and, upon due application to such commander, is refused redress, may complain to the General commanding in the State or Territory where such regiment is stationed. The general shall examine into said complaint and take proper measures for redressing the wrong complained of; and he shall, as soon as possible, transmit to the Department of War a true statement of such complaint, with the proceedings had thereon.

ART. 30. Any soldier who thinks himself wronged by any officer may complain to the commanding officer of his regiment, who shall summon a Regimental Court-Martial for the doing of justice to the complainant. Either party may appeal from such Regimental Court-Martial to a General Court-Martial; but if, upon such second hearing, the appeal appears to be groundless and vexatious, the party appealing shall be punished at the discretion of said General Court-Martial.

ART. 31. Any officer or soldier who lies out of his quarters, garrison, or camp, without leave from his superior officer, shall be punished as a Court-Martial may direct.

ART. 32. Any soldier who absents himself from his troop, battery, company, or detachment, without leave from his Commanding Officer, shall be punished as a Court-Martial may direct.

ART. 33. Any officer or soldier who fails, except when prevented by sickness or other necessity, to repair, at the fixed time, to the place of parade, exercise, or other rendezvous appointed by his Commanding Officer, or goes from the same, without leave from his Commanding Officer, before he is dismissed or relieved, shall be punished as a Court-Martial may direct.

ART. 34. Any soldier who is found one mile from camp, without leave in writing from his Commanding Officer, shall be punished as a Court-Martial may direct.

ART. 35. Any soldier who fails to retire to his quarters or tent at the beating of retreat shall be punished according to the nature of his offense.

ART. 36. No soldier belonging to any regiment, troop, battery, or company shall hire another to do his duty for him, or be excused from duty, except in cases of sickness, disability, or leave of absence. Every such soldier found guilty of hiring his duty, and the person so hired to do another's duty, shall be punished as a Court-Martial may direct.

ART. 37. Every non-commissioned officer who connives at such hiring of duty shall be reduced. Every officer who knows and allows such practices shall be punished as a Court-Martial may direct.

ART. 38. Any officer who is found drunk on his guard, party, or other duty shall be dismissed from the service. Any soldier who so offends shall suffer such punishment as a Court-Martial may direct.

ART. 39. Any sentinel who is found sleeping upon his post, or who leaves it before he is regularly relieved, shall suffer death, or such other punishment as a Court-Martial may direct.

ART. 40. Any officer or soldier who quits his guard, platoon, or division without leave from his Superior Officer, except in case of urgent necessity, shall be punished as a Court-Martial may direct.

ART. 41. Any officer who, by any means whatsoever, occasions false alarms in camp, garrison, or quarters, shall suffer death, or such other punishment as a Court-Martial may direct.

ART. 42. Any officer or soldier who misbehaves himself before the enemy, runs away, or shamefully abandons any fort, post, or guard, which he is commanded to defend, or speaks words inducing others to do the like, or casts away his arms or ammunition, or quits his post or colors to plunder or pillage, shall suffer death, or such other punishment as a Court-Martial may direct.

ART. 43. If any commander of any garrison, fortress, or post is compelled by the officers and soldiers under his command to give up to the enemy or to abandon it, the officers or soldiers so offending shall suffer death, or such other punishment as a Court-Martial may direct.

ART. 44. Any person belonging to the armies of the United States who makes known the watchword to any person not entitled to receive it, according to the rules and discipline of war, or presumes to give a parole or watchword different from that which he received, shall suffer death, or such other punishment as a Court-Martial may direct.

ART. 45. Whosoever relieves the enemy with money, victuals, or ammunition, or knowingly harbors or protects an enemy, shall suffer death, or such other punishment as a Court-Martial may direct.

ART. 46. Whosoever holds correspondence with, or gives intelligence to, the enemy, either directly or indirectly, shall suffer death, or such other punishment as a Court-Martial may direct.

ART. 47. Any officer or soldier who, having received pay, or having been duly enlisted in the service of the United States, deserts the same, shall, in time of war, suffer death, or such other punishment as a Court-Martial may direct; and in time of peace, any punishment, excepting death, which a Court-Martial may direct.

ART. 48. Every soldier who deserts the service of the United States shall be liable to serve for such period as shall, with the time he may have served previous to his desertion, amount to the full term of his enlistment; and such soldier shall be tried by a Court-Martial and punished, although the term of his enlistment may have elapsed previous to his being apprehended and tried.

ART. 49. Any officer who, having tendered his resignation, quits his post or proper duties without leave, and with intent to remain permanently absent therefrom, prior to due notice of the acceptance of the same, shall be deemed and punished as a deserter.

ART. 50. No non-commissioned officer or soldier shall enlist himself in any other regiment, troop, or company without a regular discharge from the regiment, troop, or company in which he last served, on penalty of being reputed a deserter, and suffering accordingly. And in case any officer shall knowingly receive and entertain such non-commissioned officer or soldier, or shall not, after his being discovered to be a deserter, immediately confine him and give notice thereof to the corps in which he last served, the said officer shall, by a Court-Martial, be cashiered.

ART. 51. Any officer or soldier who advises or persuades any other officer or soldier to desert the service of the United States shall, in time of war, suffer death, or such other punishment as a Court-Martial may direct; and in time of peace, any punishment, excepting death, which a Court-Martial may direct.

ART. 52. It is earnestly recommended to all officers and soldiers diligently to attend divine service. Any officer who behaves indecently or irreverently at any place of divine worship shall be brought before a General Court-Martial, there to be publicly and severely reprimanded by the President thereof. Any soldier who so offends shall, for his first offense, forfeit one sixth of a dollar; for each further offense he shall forfeit a like sum, and shall be confined twenty-four hours. The money so forfeited shall be deducted from his next pay, and shall be applied, by the Captain or senior officer of his troop, battery, or company, to the use of the sick soldiers of the same.

ART. 53. Any officer who uses any profane oath or execration shall, for each offense, forfeit and pay one dollar. Any soldier who so offends shall incur the penalties provided in the preceding Article; and all moneys forfeited for such offenses shall be applied as therein provided.

ART. 54. Every officer commanding in quarters, garrison, or on the march shall keep good order, and, to the utmost of his power, redress all abuses or disorders which may be committed by any officer or soldier under his command; and if, upon complaint made to him of officers or soldiers beating or otherwise ill-treating any person, disturbing fairs, or markets, or committing any kind of riot, to the disquieting of the citizens of the United States, he refuses or omits to see justice done to the offender, and reparation made to the party injured, so far as part of the offender's pay shall go toward such reparation, he shall be dismissed from the service, or otherwise punished as a Court-Martial may direct.

ART. 55. All officers and soldiers are to behave themselves orderly in quarters and on the march; and whoever commits any waste or spoil, either in walks or trees, parks, warrens, fish-ponds, houses, gardens, grain-fields, inclosures, or meadows, or maliciously destroys any property whatsoever belonging to inhabitants of the United States (unless by order of a General Officer commanding a separate army in the field), shall, besides such penalties as he may be liable to by law, be punished as a Court-Martial may direct.

ART. 56. Any officer or soldier who does violence to any person bringing provisions or other necessaries to the camp, garrison, or quarters of the forces of the United States in foreign parts shall suffer death, or such other punishment as a Court-Martial may direct.

ART. 57. Whosoever, belonging to the Armies of the United States in foreign parts, or at any place within the United States or their Territories during rebellion against the supreme authority of the United States, forces a safeguard, shall suffer death.

ART. 58. In time of war, insurrection, or rebellion, larceny, robbery, burglary, arson, mayhem, manslaughter, murder, assault and battery with an intent to kill, wounding, by shooting or stabbing, with an intent to commit murder, rape, or assault and battery with an intent to commit rape, shall be punishable by the sentence of a General Court-Martial, when committed by persons in the military service of the United States, and the punishment in any such case shall not be less than the punishment provided for the like offense by the laws of the State, Territory, or District in which such offense may have been committed.

ART. 59. When any officer or soldier is accused of a capital crime, or of any offense against the person or property of any citizen of any of the United States, which is punishable by the laws of the land, the commanding officer, and the officers of the regiment, troop, battery, company, or detachment to which the person so accused belongs, are required, except in time of war, upon application duly made by or in behalf of the party injured, to use their utmost endeavors to deliver him over to the civil magistrate, and to aid the officers of justice in apprehending and securing him, in order to bring him to trial. If, upon such application, any officer refuses or willfully neglects, except in time of war, to deliver over such accused person to the civil magistrates, or to aid the officers of justice in apprehending him, he shall be dismissed from the service.

ART. 60. Any person in the military service of the United States who makes or causes to be made any claim against the United States, or any officer thereof, knowing such claim to be false or fraudulent; or

Who presents or causes to be presented to any person in the civil or military service thereof, for approval or payment, any claim against the United States or any officer thereof, knowing such claim to be false or fraudulent; or

Who enters into any agreement or conspiracy to defraud the United States by obtaining, or aiding others to obtain, the allowance or payment of any false or fraudulent claim; or

Who, for the purpose of obtaining, or aiding others to obtain, the approval, allowance, or payment of any claim against the United States or against any officer thereof, makes or uses, or procures or advises the making or use of, any writing or other paper, knowing the same to contain any false or fraudulent statement; or

Who, for the purpose of obtaining, or aiding others to obtain, the approval, allowance, or payment of any claim against the United States or any officer thereof, makes, or procures or advises the making of, any oath to any fact or to any writing or other paper, knowing such oath to be false; or

Who, for the purpose of obtaining, or aiding others to obtain, the approval, allowance, or payment of any claim against the United States or any officer thereof, forges or counterfeits, or procures or advises the forging or counterfeiting of, any signature upon any writing or other paper, or uses or procures or advises the use of, any such signature, knowing the same to be forged or counterfeited; or

Who, having charge, possession, custody, or control of any money or other property of the United States, furnished or intended for the military service thereof, knowingly delivers, or causes to be delivered, to any person having authority to receive the same, any amount thereof less than that for which he receives a certificate or receipt; or

Who, being authorized to make or deliver any paper certifying the receipt of any property of the United States, furnished or intended for the military service thereof, makes, or delivers to any person, such writing, without having full knowledge of the truth of the statements therein contained, and with intent to defraud the United States; or

Who steals, embezzles, knowingly and willfully misappropriates, applies to his own use or benefit, or wrongfully or knowingly sells or disposes of any ordnance, arms, equipments, ammunition, clothing, subsistence-stores, money, or other property of the United States, furnished or intended for the military service thereof; or

Who knowingly purchases, or receives in pledge for any obligation or indebtedness, from any soldier, officer, or other person who is a part of or employed in said forces or service, any ordnance, arms, equipments, ammunition, clothing, subsistence-stores, or other property of the United States, such soldier, officer, or other person not having lawful right to sell or pledge the same,—

Shall, on conviction thereof, be punished by fine or imprisonment, or by such other punishment as a Court-Martial may adjudge. And if any person, being guilty of any of the offenses aforesaid while in the military service of the United States, receives his discharge or is dismissed from the service, he shall continue to be liable to be arrested and held for trial and sentence by a Court-Martial, in the same manner and to the same extent as if he had not received such discharge nor been dismissed.

ART. 61. Any officer who is convicted of conduct unbecoming an officer and a gentleman shall be dismissed from the service.

ART. 62. All crimes not capital, and all disorders and neglects, which officers and soldiers may be guilty of, to the prejudice of good order and military discipline, though not mentioned in the foregoing Articles of War, are to be taken cognizance of by a General or a Regimental Garrison, or Field-Officers' Court-Martial, according to the nature and degree of the offense, and punished at the discretion of such Court.

ART. 63. All retainers to the camp, and all persons serving with the Armies of the United States in the field, though not enlisted soldiers, are to be subject to orders, according to the rules and discipline of war.

ART. 64. The officers and soldiers of any troops, whether militia or others, mustered and in pay of the United States, shall, at all times and in all places, be governed by the Articles of War, and shall be subject to be tried by Courts-Martial.

ART. 65. Officers charged with crime shall be arrested and be confined in their barracks, quarters, or tents, and be deprived of their swords by the Commanding Officer. And any officer who leaves his confinement before he is set at liberty by his Commanding Officer shall be dismissed from the service.

ART. 66. Soldiers charged with crimes shall be confined until tried by Court-Martial or released by proper authority.

ART. 67. No provost-marshal, or officer commanding a guard, shall refuse to receive or keep any prisoner committed to his charge by an officer belonging to the forces of the United States; provided the officer committing shall, at the same time, deliver an account in writing, signed by himself, of the crime charged against the prisoner.

ART. 68. Every officer to whose charge a prisoner is committed shall, within twenty-four hours after such commitment, or as soon as he is relieved from his guard, report in writing, to the Commanding Officer, the name of such prisoner, the crime charged against him, and the name of the officer committing him; and if he fails to make such report, he shall be punished as a Court-Martial may direct.

ART. 69. Any officer who presumes, without proper authority, to release any prisoner committed to his charge, or suffers any prisoner so committed to escape, shall be punished as a Court-Martial may direct.

ART. 70. No officer or soldier put in arrest shall be continued in confinement more than eight days, or until such time as a Court-Martial can be assembled.

ART. 71. When an officer is put in arrest for the purpose of trial, except at remote military posts or stations, the officer by whose order he is arrested shall see that a copy of the charges on which he is to be tried is served upon him within eight days after his arrest, and that he is brought to trial within ten days thereafter, unless the necessities of the service prevent such trial; and then he shall be brought to trial within thirty days after the expiration of said ten days. If a copy of the charges be not served, or the arrested officer be not brought to trial, as herein required, the arrest shall cease. But officers released from arrest, under the provisions of this Article, may be tried, whenever the exigencies of the service shall permit, within twelve months after such release from arrest.

ART. 72. Any General Officer, commanding the Army of the United States, a separate army, or a separate department, shall be competent to appoint a General Court-Martial, either in time of peace or in time of war. But when any such commander is the accuser or prosecutor of any officer under his command, the Court shall be appointed by the President, and its proceedings and sentence shall be sent directly to the Secretary of War, by whom they shall be laid before the President, for his approval or orders in the case.

ART. 73. In time of war the commander of a division, or of a separate brigade of troops, shall be competent to appoint a General Court-Martial. But when such commander is the accuser or prosecutor of any person under his command, the Court shall be appointed by the next higher commander.

ART. 74. Officers who may appoint a Court-Martial shall be competent to appoint a Judge-Advocate for the same.

ART. 75. General Courts-Martial may consist of any number of officers from five to thirteen, inclusive; but they shall not consist of less than thirteen when that number can be convened without manifest injury to the service.

ART. 76. When the requisite number of officers to form a General Court-Martial is not present in any post or detachment, the Commanding Officer shall, in cases which require the cognizance of such a Court, report to the Commanding Officer of the Department, who shall thereupon order a Court to be assembled at the nearest post or department at which there may be such a requisite number of officers, and shall order the party accused, with necessary witnesses, to be transported to the place where the said Court shall be assembled.

ART. 77. Officers of the Regular Army shall not be competent to sit on Courts-Martial to try the officers or soldiers of other forces, except as provided in Article 78.

ART. 78. Officers of the Marine Corps, detached for service with the Army by order of the President, may be associated with officers of the Regular Army on Courts-Martial for the trial of offenders belonging to the Regular Army, or to forces of the Marine Corps so detached; and in such cases the orders of the senior officer of either corps, who may be present and duly authorized, shall be obeyed.

ART. 79. Officers shall be tried only by General Courts-Martial; and no officer shall, when it can be avoided, be tried by officers inferior to him in rank.

ART. 80. In time of war a field-officer may be detailed in every regiment, to try soldiers thereof for offenses not capital; and no soldier, serving with his regiment, shall be tried by a Regimental or Garrison Court-Martial when a field-officer of his regiment may be so detailed.

ART. 81. Every officer commanding a regiment or corps shall, subject to the provisions of Article 80, be competent to appoint, for his own regiment or corps, Courts-Martial, consisting of three officers, to try offenses not capital.

ART. 82. Every officer commanding a garrison, fort, or other place, where the troops consist of different corps, shall, subject to the provisions of Article 80, be competent to Appoint, for such Garrison or other place, Courts-Martial, consisting of three officers, to try offenses not capital.

ART. 83. Regimental and Garrison Courts-Martial, and field-officers detailed to try offenders, shall not have power to try capital cases or commissioned officers, or to inflict a fine exceeding one month's pay, or to imprison or put to hard labor any non-commissioned officer or soldier for a longer time than one month.

ART. 84. The Judge-Advocate shall administer to each member of the court, before they proceed upon any trial, the following oath, which shall also be taken by all members of regimental and garrison courts-martial: "You, A. B., do swear that you will well and truly try and determine, according to evidence, the matter now before you, between the United States of America and the prisoner to be tried, and that you will duly administer justice, without partiality, favor, or affection, according to the provisions of the Rules and Articles for the government of the Armies of the United States, and if any doubt should arise, not explained by said Articles, then according to your conscience, the best of your understanding, and the custom of war in like cases; and you do further swear that you will not divulge the sentence of the Court until it shall be published by the proper authority; neither will you disclose or discover the vote or opinion of any particular member of the Court-Martial, unless required to give evidence thereof, as a witness, by a Court of Justice, in a due course of law. So help you God."

ART. 85. When the oath has been administered to the members of a Court-Martial, the President of the Court shall administer to the Judge-Advocate, or person officiating as such, an oath in the following form: "You, A. B., do swear that you will not disclose or discover the vote or opinion of any particular member of the Court-Martial, unless required to give evidence thereof, as a witness, by a Court of Justice, in due course of law; nor divulge the sentence of the Court to any but the proper authority, until it shall be duly disclosed by the same. So help you God."

ART. 86. A Court-Martial may punish, at discretion, any person who uses any menacing words, signs, or gestures in its presence, or who disturbs its proceedings by any riot or disorder.

ART. 87. All members of a Court-Martial are to behave with decency and calmness.

ART. 88. Members of a Court-Martial may be challenged by a prisoner, but only for cause stated to the Court. The Court shall determine the relevancy and validity thereof, and shall not receive a challenge to more than one member at a time.

ART. 89. When a prisoner, arraigned before a General Court-Martial, from obstinacy and deliberate design stands mute, or answers foreign to the purpose, the Court may proceed to trial and judgment, as if the prisoner had pleaded not guilty.

ART. 90. The Judge-Advocate, or some person deputed by him, or by the General or officer commanding the Army, detachment, or garrison, shall prosecute in the name of the United States; but when the prisoner has made his plea, he shall so far consider himself counsel for the prisoner as to object to any leading question to any of the witnesses, and to any question to the prisoner, the answer to which might tend to criminate himself.

ART. 91. The depositions of witnesses residing beyond the limits of the State, Territory, or District in which any Military Court may be ordered to sit, if taken on reasonable notice to the opposite party and duly authenticated, may be read in evidence before such Court in cases not capital.

ART. 92. All persons who give evidence before a court-martial shall be examined on oath, or affirmation, in the following form: "You swear (or affirm) that the evidence you shall give, in the case now in hearing, shall be the truth, the whole truth, and nothing but the truth. So help you God."

ART. 93. A Court-Martial shall, for reasonable cause, grant a continuance to either party, for such a time, and as often, as may appear to be just: *Provided*, That if the prisoner be in close confinement, the trial shall not be delayed for a period longer than sixty days.

ART. 94. Proceedings of trials shall be carried on only between the hours of eight in the morning and three in the afternoon, excepting in cases which, in the opinion of the officer appointing the Court, require immediate example.

ART. 95. Members of a Court-Martial, in giving their votes, shall begin with the youngest in commission.

ART. 96. No person shall be sentenced to suffer death except by the concurrence of two thirds of the members of a General Court-Martial, and in the cases herein expressly mentioned.

ART. 97. No person in the military service shall, under the sentence of a Court-Martial, be punished by confinement in a penitentiary unless the offense of which he may be convicted would, by some statute of the United States, or by some statute of the State, Territory, or District in which such offense may be committed, or by the common laws as the same exists in such State, Territory, or District, subject such convict to such punishment.

ART. 98. No person in the military service shall be punished by flogging, or by branding, marking, or tattooing on the body.

ART. 99. No officer shall be discharged or dismissed from the service except by order of the President, or by sentence of a General Court-Martial; and in time of peace no officer shall be dismissed except in pursuance of the sentence of a Court-Martial, or in mitigation thereof.

ART. 100. When an officer is dismissed from the service for cowardice or fraud, the sentence shall further direct that the crime, punishment, name, and place of abode of the delinquent shall be published in the newspapers in and about the camp, and in the State from which the offender came, or where he usually resides; and after such publication it shall be scandalous for an officer to associate with him.

ART. 101. When a Court-Martial suspends an officer from command, it may also suspend his pay and emoluments for the same time, according to the nature of his offense.

ART. 102. No person shall be tried a second time for the same offense.

ART. 103. No person shall be liable to be tried and punished by a General Court-Martial for an offense which appears to have been committed more than two years before the issuing of the order for such trial, unless, by reason of having absented himself, or of some other manifest impediment, he shall not have been amenable to justice within that period.

ART. 104. No sentence of a Court-Martial shall be carried into execution until the whole proceedings shall have been approved by the officer ordering the Court, or by the officer commanding for the time being.

ART. 105. No sentence of a Court-Martial inflicting the punishment of death shall be carried into execution until it shall have been confirmed by the President; except in the cases of persons convicted, in time of war, as spies, mutineers, deserters, or murderers, and in the cases of guerrilla marauders convicted, in time of war, of robbery, burglary, arson, rape, assault with intent to commit rape, or of violation of the laws and customs of war; and in such accepted cases the sentence of death may be carried into execution upon confirmation by the Commanding General in the Field, or the Commander of the Department, as the case may be.

ART. 106. In time of peace no sentence of a Court-Martial directing the dismissal of an officer shall be carried into execution until it shall have been confirmed by the President.

ART. 107. No sentence of a Court-Martial appointed by the commander of a division or of a separate brigade of troops, directing the dismissal of an officer, shall be carried into execution until it shall have been confirmed by the General commanding the Army in the Field to which the division or brigade belongs.

ART. 108. No sentence of a Court-Martial, either in time of peace or in time of war, respecting a General Officer, shall be carried into execution until it shall have been confirmed by the President.

ART. 109. All sentences of a Court-Martial may be confirmed and carried into execution by the officer ordering the Court, or by the officer commanding for the time being, where confirmation by the President, or by the Commanding General in the Field, or Commander of the Department, is not required by these Articles.

ART. 110. No sentence of a Field-Officer detailed to try soldiers of his regiment shall be carried into execution until the whole proceedings shall have been approved by the Brigade Commander, or, in case there be no Brigade Commander, by the Commanding Officer of the post.

ART. 111. Any officer who has authority to carry into execution the sentence of death or of dismissal of an officer may suspend the same until the pleasure of the President shall be known; and in such case he shall immediately transmit to the President a copy of the order of suspension, together with a copy of the proceedings of the Court.

ART. 112. Every officer who is authorized to order a General Court-Martial shall have power to pardon or mitigate any punishment adjudged by it, except the punishment of death or of dismissal of an officer. Every officer commanding a regiment or garrison in which a Regimental or Garrison Court-Martial may be held shall have power to pardon or mitigate any punishment which such Court may adjudge.

ART. 113. Every Judge-Advocate, or person acting as such, at any General Court-Martial, shall, with as much expedition as the opportunity of time and distance of place may permit, forward the original proceedings and sentence of such Court to the Judge-Advocate-General of the Army, in whose office they shall be carefully preserved.

ART. 114. Every party tried by a General Court-Martial shall, upon demand thereof, made by himself or by any person in his behalf, be entitled to a copy of the proceedings and sentence of such Court.

ART. 115. A Court of Inquiry to examine into the nature of any transaction of, or accusation or imputation against, any officer or soldier, may be ordered by the President or by any Commanding Officer; but, as Courts of Inquiry may be perverted to dishonorable purposes, and may be employed, in the hands of weak and envious Commandants, as engines for the destruction of military merit, they shall never be ordered by any Commanding Officer, except upon a demand by the officer or soldier whose conduct is to be inquired of.

ART. 116. A Court of Inquiry shall consist of one or more officers, not exceeding three, and a Recorder, to reduce the proceedings and evidence to writing.

ART. 117. The Recorder of a Court of Inquiry shall administer to the members the following oath: "You shall well and truly examine and inquire, according to the evidence, into the matter now before you, without partiality, favor, affection, prejudice, or hope of reward: so help you God." After which the President of the Court shall administer to the Recorder the following oath: "You, A. B., do swear that you will, according to your best abilities, accurately and impartially record the proceedings of the Court and the evidence to be given in the case in hearing: so help you God."

ART. 118. A Court of Inquiry, and the Recorder thereof, shall have the same power to summon and examine witnesses as is given to Courts-Martial and the Judge-Advocates thereof. Such witnesses shall take the same oath which is taken by witnesses before Courts-Martial, and the party accused shall be permitted to examine and cross-examine them, so as fully to investigate the circumstances in question.

ART. 119. A Court of Inquiry shall not give an opinion on the merits of the case inquired of unless specially ordered to do so.

ART. 120. The proceedings of a Court of Inquiry must be authenticated by the signatures of the Recorder and the President thereof, and delivered to the Commanding Officer.

ART. 121. The proceedings of a Court of Inquiry may be admitted as evidence by a Court-Martial, in cases not capital, nor extending to the dismissal of an officer: *Provided*, That the circumstances are such that oral testimony cannot be obtained.

ART. 122. If, upon marches, guards, or in quarters, different Corps of the Army happen to join or do duty together, the officer highest in rank of the Line of the Army, Marine Corps, or Militia, by commission, there on duty or in quarters, shall command the whole, and give orders for what is needful to the service, unless otherwise specially directed by the President, according to the nature of the case.

ART. 123. In all matters relating to the rank, duties, and rights of officers, the same rules and regulations shall apply to officers of the Regular Army and to volunteers commissioned in, or mustered into, said service, under the laws of the United States, for a limited period.

ART. 124. Officers of the militia of the several States, when called into the service of the United States, shall on all detachments, Courts-Martial, and other duty wherein they may be employed in conjunction with the regular or volunteer forces of the United States, take rank next after all officers of the like grade in said regular or volunteer forces, notwithstanding the commissions of such militia officers may be older than the commissions of the said officers of the regular or volunteer forces of the United States.

ART. 125. In case of the death of any officer, the Major of his regiment, or the officer doing the Major's duty, or the second officer in command at any post or garrison, as the case may be, shall immediately secure all his effects then in camp or quarters, and shall make, and transmit to the office of the Department of War, an inventory thereof.

ART. 126. In case of the death fo any soldier, the Commanding Officer of his troop, battery, or company shall immediately secure all his effects then in camp or quarters, and shall, in the presence of two other officers, make an inventory thereof, which he shall transmit to the office of the Department of War.

ART. 127. Officers charged with the care of the effects of deceased officers or soldiers shall account for and deliver the same, or the proceeds thereof, to the legal representatives of such deceased officers or soldiers. And no officer so charged shall be permitted to quit the regiment or post until he has deposited in the hands of the Commanding Officer all the effects of such deceased officers or soldiers not so accounted for and delivered.

ART. 128. The foregoing Articles shall be read and published once in every six months, to every garrison, regiment, troop, or company in the service of the United States, and shall be duly observed and obeyed by all officers and soldiers in said service.

All persons who, in time of war, or of rebellion against the supreme authority of the United States, are found lurking or acting as spies, in or about any of the fortifications, posts, quarters, or encampments of any of the armies of the United States, or elsewhere, are triable by a General Court-Martial, or by a Military Commission, and on conviction thereof suffer death.

ARTIFICE.—Among the French, a term understood as comprehending everything which enters the composition of fire-works, as the sulphur, saltpeter, charcoal, etc. See *Fire-works*.

ARTIFICER.—1. One who makes fire-works, or works in the artillery laboratory and prepares the shells, fuses, grenades, etc. 2. A military mechanic, such as a carpenter, blacksmith, or mason.

ARTIFICIAL LIMBS.—From the days of the German knight Götz von Berlichingen, artificial arms have been made which have been marvels of ingenuity. Even the arm of that famous knight, still on exhibition in a German museum, is a piece of mechanism so intricate in the combination of its motions as to have been without a rival for nearly five hundred years. All modern improvements belong to the present decade.

The tendency of the manufacturers—modern as well as ancient—has been to make an arm with every motion of the natural; in this they have succeeded—that is, so far as patterning after Götz and producing an article very primitive in its construction, too complicated to be durable and too intricate to be serviceable. Until man becomes capable of combining art with nature and harmonizing the artificial member with the nervous system, in short, giving it life, he will fail in supplying the loss in all its detail. Any amount of machinery will not accomplish it; and the more complication he has, the more distant he gets from the most useful substitute. A glance at the anatomy of the human arm reveals it as a marvel of mechanism. What a combination of movements, and what unlimited control man has over it! Each finger has its three joints, with every joint under control. The hand has its wrist, enabling it to conform to any angle. The forearm has the ulna and the radius, enabling the hand to rotate. Withal, what marvelous strength each finger and joint commands, all operated by sinews and muscles, each joint supplied with cushions and a lubricating sac, whose function it is to reduce friction to the minimum. The parts of this wonderful machine are hinged together with such nicety that the engraver is enabled to etch the finest plate, or the brawny smith to wield the heaviest sledge.

Does the reader think that the hand alone does this variety of work?—Operates voluntarily by an intelligence of its own? Sever the brachial nerve, and we will have a member as dead and limpsy as an empty coat-sleeve. Remove the arm from the body and irritate the nerves or contract the muscles, and we will have a motion as awkward and spasmodic as may be observed in an artificial arm with jointed fingers. Hence all the dexterous movements we observe in the normal hand depend upon some power outside of itself, and that power is the mind. If we look a little deeper in the physiology of the natural arm and hand we will observe that nature has made a curious provision for one of its failings. Every joint suffers wear from attrition, and were it not for this provision they would soon become loose and rattle as bad as a worn-out gudgeon. Not a drop of blood flows through the avenues of the hand that does not carry with it fresh material to supply the wasted parts. From the first beat of the heart of the child not yet born, until man has ceased to be an animate being, this human repair-shop is in active operation and knows no rest. This cursory glance at the natural arm will fix in the mind three facts: first, that the hand is a delicate piece of mechanism of great strength; second, that it is in concert with and operated by the human will; and third, that it suffers wear, but is constantly undergoing repairs by the action of the circulatory system.

With these facts well impressed, we may make a comparison with the artificial arm. What a disparity! It cannot be connected with the mind, nor with the heart. If the joints of the fingers are made strong enough to withstand a small proportion of the strain of the natural hand, it must necessarily be made too

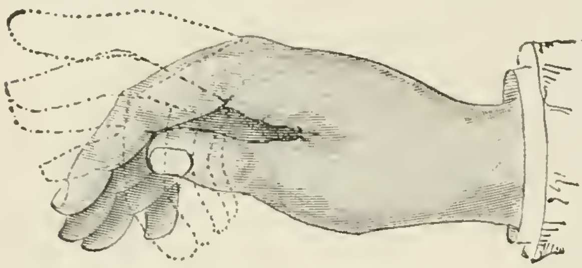


Fig. 1.—The Marks Rubber Hand.

heavy for endurance. If the springs are made stiff enough to have a grasping power of a pound, the exertion to operate them is fatiguing and renders them impracticable.

Nothing has tended so much to the very highest development of artificial arms and hands as an accident which happened more than a quarter of a century ago to the celebrated French tenor M. Roger, who lost his right arm above the elbow. It was necessary for his future appearance on the stage that he should have an artificial limb which would serve the purposes of histrionic action and permit him to grasp a sword and draw it from its scabbard. Such a contrivance was invented in 1845 by Van Petersen a Prussian mechanician, and the French Academy of Sciences commissioned MM. Gambey, Rayer, Velpeau, and Magendie to report upon it. For a history of the nature of the limb, the reader is referred to the

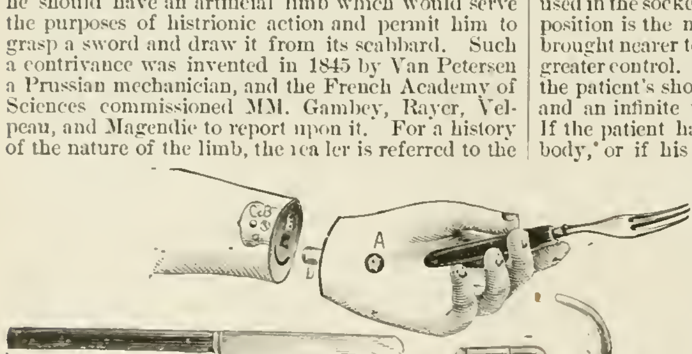


Fig. 2.—Applications of the Marks Hand.

report which appeared in the *Comptes Rendus* for that date. The apparatus, which weighs less than 18 ounces, was tested upon a soldier who had lost both arms. By its aid he was enabled to pick up a pen, take hold of a leaf of paper, etc.; and the old man's joy during the experiment was so great that the Academy presented him with a pair of these arms. Van Petersen's conceptions have been extended and improved by Messrs. Charrière, the celebrated surgical mechanics of Paris, aided by M. Huguier, the well-known surgeon. A very marvelous arm has also been almost simultaneously constructed by M. Bechard, which, by means of a single point of traction, placed in pronation, executes first the movement of supination, next in succession the extension of the fingers and abduction of the thumb: the hand is then wide open.

In 1863, Mr. A. A. Marks, an American of varied experience, invented the rubber hand (Fig. 1), which was attached to the forearm by means of a spindle held in position by a set-screw, easily detached and replaced by a hook, fork, knife, or brush. The fingers were of soft, elastic rubber, molded to a graceful shape and yielding to pressure. Its advantages were its naturalness in appearance and to the touch, and its great durability. It might fall or strike anything without breaking or impairing it. These advantages alone commended it to favor, and many of them were made. In the course of time an improvement was suggested—that of making the fingers ductile, so that they might be made to assume different positions; by the assistance of the opposite hand, or by pressing the hand against any hard surface, the fingers may be placed in any desired position, each one giving the hand a new appearance; thus obviating the monotony of the old style, and making it more pleasing to the wearing and less observable to the inquisitive. The fingers, when bent, will hold a valise or package of considerable weight, or hold the reins of a horse in driving.

Fig. 2 represents the manner in which the hand is now attached to the fore-arm; also the attachment in the palm of hand for holding various useful articles. It may be thus described: The hand is held to the forearm by inserting the spindle, D, in the socket, E; it is then locked by a spring. The hand in this position has a rotary motion. A knife, fork, brush, or hook can be inserted in the palm. The knife or fork will enable the wearer to feed himself without exhibiting his loss; the hook to carry heavy weights and perform laborious work; the brush will enable the wearer to wash his opposite hand. By pressing on the button, A, these articles may be released; by pressing on the button, C, the hand can be detached, and any of the articles above named may be used in the socket without the hand. The hook in this position is the most useful appendage; it is thereby brought nearer to the stump, and, consequently, under greater control. By it as much weight can be carried as the patient's shoulder will endure; shoveling, hauling, and an infinite variety of heavy work can be done. If the patient has suffered an amputation close to the body, or if his hand is unjointed at the wrist, it is more desirable, for obvious reasons, to dispense with the wrist-attachment and depend on the palm-attachment entirely for holding these articles.

Fig. 3 represents an arm and hand for amputation below the elbow. The hand is dressed with a glove (which is always to be worn), holding a pen in the act of writing. This has been regarded as a wonderful accomplishment, when, really, it is less difficult than many services the hand is capable of performing. The joints at the elbow are of leather, thus affording a rotary motion to the forearm which cannot be had with steel joints.

Fig. 4 represents an artificial arm for amputation above the elbow. The joint is adjustable, and can be tightened or loosened as the patient desires. The arm is held to the person by straps or suspenders passing over and under the opposite shoulder. The elbow-joint is operated by a leather cord attached to the forearm and passing through the upper arm, and attached by a buckle to the suspender. By urging the shoulder forward this cord is drawn upon and the forearm brought to any desired angle. It is thus seen that the arm and hand are simple in their construction, practical in their application, light, strong, and durable.

Artificial legs, having fewer requirements to perform than artificial arms, are comparatively simple in structure. The ordinary *Bucket-leg*, in common

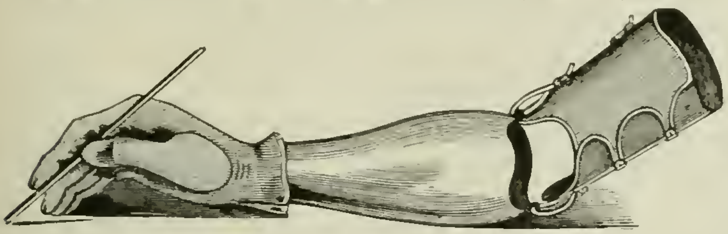


Fig. 3.—Arm and Hand for Amputation below the Elbow.

use amongst the poorer classes, consists of a hollow sheath or bucket, accurately conformed to the shape

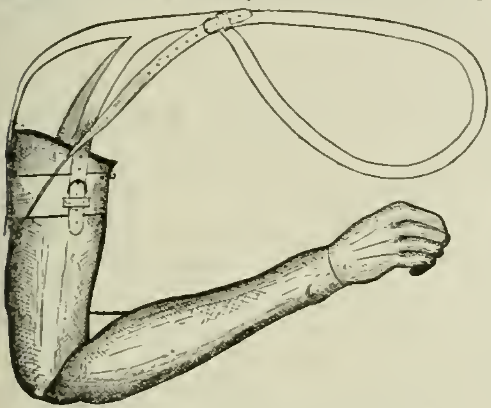
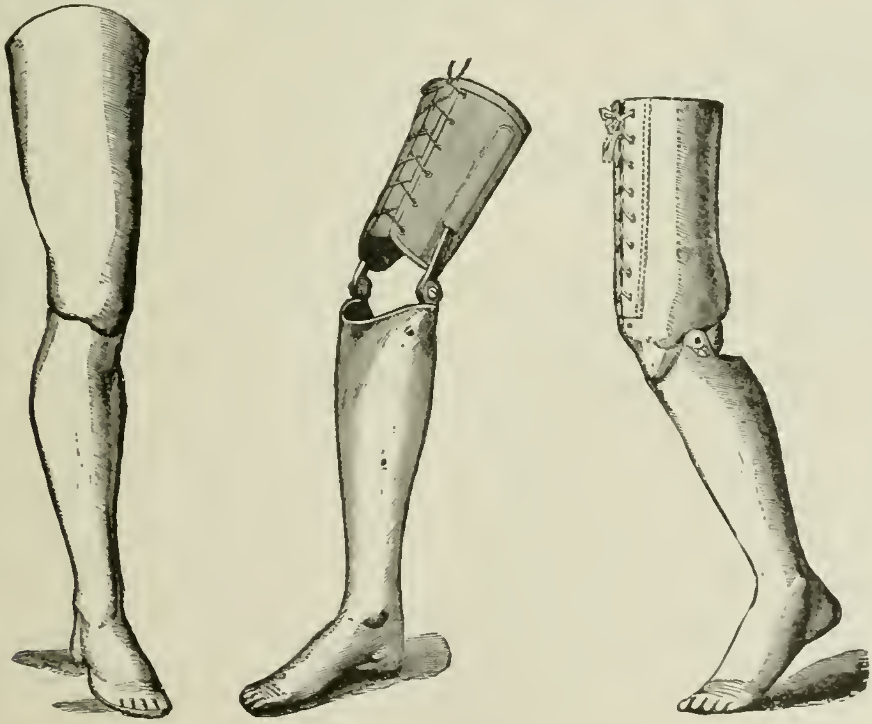


Fig. 4.—Arm for Amputation above the Elbow.

of the stump, and having—in lieu of the more symmetric proportions of the leg—a "pin" placed at its



A B C

Fig. 5.—The Marks Rubber Legs.

lower end to insure connection between it and the ground. This form of leg is strongly to be recommended when expense is an object, as it really fulfills all the conditions excepting external similitude embraced by a better piece of mechanism. It is likewise occasionally employed with benefit by those patients who, from lack of confidence, prefer learning the use of an artificial leg by first practicing with the commonest substitute. As, when the body rests on a single leg, the center of gravity passes through the tuberosity of the ischium, it is essential that the *bucket* should be so made as to have its sole point of bearing against this part of the pelvis.

Of the more complicated forms of artificial leg, four are especially popular. The first of these is of English origin, and, owing to its having been adopted by the late Marquis of Anglesea, is known as the *Anglesea-leg*. For a description of it the reader is referred to Gray's work on "Artificial Limbs," one of the firm of Grays having been the constructor of the legs used by the Marquis. This was for a long time *the* fashionable artificial leg. The second leg worthy of notice is that invented by an American named Palmer, and called the *Palmer-leg*. From its lightness and the greater ease of walking with it, it has long superseded the Anglesea leg in America. In the third of these legs, also invented in America and known as the *Bly-leg*, the principal faults of the two other legs have been completely overcome. The advantages of this leg are thus summed up: (1) Adaptation to all amputations either above or below the knee. (2) Rotation and lateral action of the ankle-joint. (3) Power on the part of the patient to walk with ease on any surface however irregular, as, owing to the motion of the ankle-joint, the sole of the foot readily accommodates itself to the unevenness of the ground, which is an advantage never before possessed by any artificial limb. (4) The ankle-joint is rendered perfectly indestructible by ordinary wear, owing to its center being composed of a glass ball resting in a cup of vulcanite. (5) The action of the ankle-joint is created by five tendons, arranged in accordance with the position assigned to them in a natural leg. These tendons are capable of being rendered tight or loose in a few instants, so that the wearer of the leg has the power of adjusting with precision the exact degree of tension from which he finds the greatest comfort in walking, and also of giving the foot any position most pleasing to the eye. (6) There is a self-acting spring in the knee-joint, urging the leg forward in walking, and imparting automatic motion, thus avoiding the least trouble to the patient, who finds the leg literally and not metaphorically walk by itself. (7) At the knee-joint there is a mechanical arrangement representing the crucial ligaments, and affording natural action to that articulation by which all shock to the stump in walking is avoided. The fourth of these legs, contrived by Mr. Marks, the inventor of the rubber hand already described, not only possesses all the valuable features of the other legs, but has novel points of value in addition. India-rubber is largely used in its construction. In the drawing (Fig 5), A represents a full-length leg standing erect, to be applied in all cases where amputation occurs above the knee-joint. B represents a leg to be applied where the leg has been amputated below the knee-joint and the stump is flexible enough and sufficiently long to enable the wearer to use it in walking. It also represents the leg with the heel compressed, and in its position after taking the step and when firmly planted on the ground. C is termed a knee-bearing leg. It is to be applied where amputation takes place below the knee, and where the stump is too short or contracted at right angles, so the knee-joint cannot be used in walking. This figure represents the leg slightly bent at the knee, and bearing well upon the toe, as in the act of lifting it to take the next advance-step.

The accompanying drawing (Fig. 6) shows the India-rubber foot before being applied to the leg. This rubber foot constitutes the main feature in the

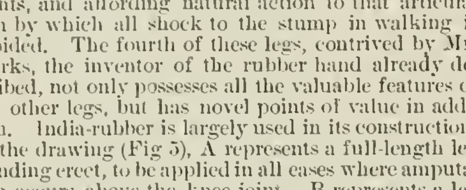


Fig. 6.—The Marks Rubber Foot.

legs shown in the figures. It is made mostly of India-rubber of a very spongy, light, and elastic character. A piece of willow wood, nearly filling the rubber heel at the top, or surface, where the leg rests, runs down about one fourth of the distance towards the lower part of the heel; also forward and downwards to the joint at the ball of the foot. This piece of wood is the base upon which the foot is built, and is also the medium whereby the foot is joined firmly to the leg. The leg itself is made of light, tough willow in all cases, except the thigh-piece shown in B, and the front part of the thigh-piece in C, both of which are made of leather. The entire leg and foot are covered with fine buckskin, neatly coated with a lifelike, waterproof finish, making it both light and strong. It will be seen that there are no movable ankle-joints in these limbs, the necessity for which being entirely obviated by the Elastic Rubber Foot, which gives all the motion required in walking, and also the ease, firmness, elasticity, and reliance absolutely necessary in a perfect artificial leg. The rubber foot also gives all the required lateral motion to the foot when stepping upon sideling or uneven ground. This leg dispenses with all machinery of whatever character, and has been in use by the Government, for officers, soldiers, and seamen who lose their limbs in service, for the last twenty years, giving great satisfaction.

Fig. 7 gives a rear view of the knee-joint of the leg, A. The T-joint is fastened to the upper part or thigh-piece of the leg, and the gudgeons of the T are held in adjustable, oblique boxes, which are easily set at any time by the screws passing through the caps into the main leg, so as to keep the joint to work tight and still, yet free and perfectly flexible, the small projecting bar attached to the T with the button-shaped ball operating upon the spiral spring, so as to throw the foot forward when bent in walking, and so as to hold the foot under when bent at right angles in a sitting position.

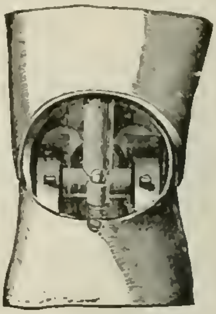


Fig. 7.

In cases of arrested development of the lower limbs, short-legged persons may be made of the ordinary height by the use of two artificial feet placed twelve or more inches below the true feet, and attached to the legs by means of metallic rods, jointed at the knee and ankle.

Other parts not entitled to be called limbs can also be replaced by mechanical art—such as the nose, lips, ears, palate, cheek, and eye. In the present advanced state of plastic surgery, deficiencies of the nose, lips, and palate can usually be remedied by an operation; cases, however, may occur where an artificial organ is required. Artificial ears are moulded of silver, painted the natural color, and fixed in their place by a spring over the vertex of the head. Loss of an eye causes sad disfigurement; but the artificial eyes of Boissonneau, which have been shown in all the recent public exhibitions, completely throw all others in the shade, and cannot be detected without the closest inspection.

In the United States service every officer, non-commissioned officer, enlisted or hired man, of the land or naval forces of the United States, who in the line of his duty as such, or through disease contracted in the service as such, loses a limb or the use of a limb, receives once every five years an artificial limb or appliance, or commutation therefor, as he shall elect, under such regulations as the Surgeon-General of the Army may prescribe; and the period of five years shall be held to commence with the filing of the first application after the seventeenth day of June, in the year 1870. The money value allowed as commutation is—for legs $75; for arms, feet, and apparatus for resection, $50 each. Necessary transportation to have artificial limbs fitted is furnished by the Quartermaster-General of the Army, the cost of which is refunded out of any money appropriated for the purchase of artificial limbs.

ARTIFICIAL LINE OF SIGHT.—In gunnery, the right line from the eye to the object to be hit, passing through the front and rear sights.

ARTIFICIAL POINT-BLANK.—Point-blank and point-blank range are terms formerly supposed to possess great importance in gunnery. The point-blank is the point at which the line of sight intersects the trajectory the second time; or, more practically speaking, it is that point which, being aimed at, is struck by the projectile. The *natural point-blank* corresponds to the *natural line of sight* when this line is horizontal, and the distance of this point from the muzzle is called the point-blank range. An *artificial point-blank* is one corresponding to an *artificial line of sight*.

To hit an object within the point-blank, the piece is aimed below it. To hit an object beyond the point-blank, the muzzle has to be raised, which is effected by elevating the notch on the rear-sight along a vertical leaf, on which are graduated distances. In this manner artificial point-blanks (corresponding to the artificial lines of sight) are established, the piece being aimed as when at point-blank. See *Point-blank*.

ARTILLERY.—The history of artillery may be said to date from the discovery of gunpowder, which is popularly attributed to Roger Bacon and Barthold Schwarz, two Monks of the thirteenth century, although a mixture of niter, charcoal, and sulphur was used for explosive purposes by the Chinese during the ninth century. Its introduction into European warfare is due to the Moors, for mention is made of artillery at Cordova in 1280. Ferdinand IV. of Castile took Gibraltar with artillery in 1309, and cannon were used at the sieges of Baza, Martos, and Alicante. This arm soon became known throughout Europe. The French availed themselves of it at the siege of Puy Guillaume in 1338, and the English had three small guns at the battle of Crécy in 1346. In the French War of Independence against the English, artillery was much used; and in 1428 Joan of Arc is said to have pointed the guns herself. The guns of the fourteenth century were of the rudest design; in the fifteenth century Charles VIII. of France used an improved artillery in his Italian campaigns, and to this arm also Louis XII. largely owed his success in Italy. Henry VII. and Henry VIII. of England did much for its advancement. During the sixteenth century brass guns and cast-iron projectiles were adopted throughout Europe, while Tartaglia in Italy made great improvements in gunnery and invented the gunner's quadrant. During the latter part of this century case-shot, the German *hagelkugel*, was invented, and shells were fired from mortars. The first half of the seventeenth century forms an era in the history of artillery. Henry IV. of France was among the first to recognize its coming importance, and occupied himself diligently with its improvement. Maurice and Henry Frederick of Nassau made much advancement in it, but it was under the great Swedish warrior, Gustavus Adolphus, that artillery first began to take its true position on the battle-field. He attached two guns to each regiment, and may, therefore, be said to be the father of the battalion system of guns; he proved its utility in the celebrated Thirty Years' War. During his life he did much to forward the science of artillery, increasing its mobility and its rapidity of fire, and raising the proportion of guns to over six for 1000 men. In England the Laboratory at Woolwich was established in 1672, and a reorganization of the artillery took place in 1682 under the Master-General Lord Dartmouth. Louis XIV. established a special artillery force, raised in 1671 a regiment for artillery duty, and in 1690 founded the first artillery schools. The inventions of the elevating-screw, the prolonge, and the priming-tube filled with powder, were made during his reign. The Prussian artillery was very backward during the first part of the eighteenth century, and Frederick the Great did not at first place much value upon its services. Although it contributed much to Frederick's victory at Rossbach, it was usually no match for the well-handled Austrian guns, which fact impressed him with the importance of giving more attention to this branch. He therefore raised the proportion of guns, and established horse-artillery in 1759.

After the Seven Years' War the Austrians recognized the importance of the artillery in modern warfare, and Prince Lichtenstein was commissioned to reorganize it. The experience of Frederick's wars was best utilized by France, and under Gribeauval, in 1765, great reforms in the French artillery were commenced. This officer had been sent to Austria during the Seven Years' War, and had held command under Prince Lichtenstein. Struck with the improvements effected in Austria, he strove on his return to build up a complete system, as to both persons and matériel, making a separate provision for field, siege, garrison, and coast artillery. At first his reforms met great opposition, but in 1776 he became First Inspector-General of Artillery, and was able to carry through his improvements. The French horse-artillery dates from 1791, and the last step in the complete organization of the field-artillery was made in 1800, when the establishment of a Driver's Corps (of soldiers) put an end to the old system of horsing by contract. Napoleon, who was a great artillery officer, introduced the tactical combination with brilliant success. To his wars we first look for instances of the important effects produced by this arm in that concentration of fire which in those days was produced only by massing guns. Napoleon III. made artillery a special subject of study; and the great treatise upon it, commenced and mainly written by him, is a standard work on the subject. Since the war of 1870–71, in which the French artillery proved itself far inferior to the German, the French have been actively engaged in experiments with a view to the introduction of superior guns, and have increased their force of artillery by 120 batteries. Similar progress has been made by the other great European Powers during this century. The British artillery had greatly deteriorated during the eighteenth century, and was not up to the standard of other countries, but horse-artillery was formed in 1793, and a Driver's Corps introduced the following year. At the commencement of the nineteenth century the Prussian artillery was powerful rather than mobile; but after the disasters of 1806–7 this defect was remedied, and in 1816 further improvement was made. In 1872 the German artillery was reorganized, the field-artillery of each army corps being augmented to 17 batteries, and divided into two regiments. The Austrian artillery has always been pre-eminent both in the excellence of its matériel and in tactical handling on the field. In 1859 rifled guns were introduced, and in 1861 gun-cotton was substituted for gunpowder, but was soon afterwards abandoned. Russia won special distinction in the Napoleonic wars by the power and good service of its artillery, and has continued to give great attention to this arm. Having adopted the breech-loading system of Prussia, Russia has increased its field-artillery from three to four batteries per division, with thirty-eight batteries of mitrailleuses added.

General William F. Barry was the organizer of the artillery of the Union armies during the Rebellion. The aggregate of field-guns was about 15,000, with 40,000 horses and 48,000 men. The number of guns of position used in field-works or intrenched lines during that war was 1200, served by about 22,000 men. There are at present in the Regular Army of the United States 5 regiments of artillery, with 284 officers and 2321 enlisted men. The personal armament of an artilleryman of the mounted batteries, whether field or siege, is a pistol and saber for the sergeants, trumpeters, and drivers; and a saber only for each cannoneer. Those serving in the sea-coast fortifications have a rifle-musket and the full equipment of an infantry soldier. The matériel of a mounted battery of the U. S. field-artillery when on a war-footing is 6 guns, 6 caissons, 1 battery-wagon, 1 traveling-forge, and 112 horses; on a peace-footing it is 6 guns, 6 caissons, and 80 horses. The ammunition of a field-battery for active service in war is 400 rounds per gun. The organization of a siege-battery in the U. S. service is 4 guns, 1 battery-wagon, 1 traveling-forge, and 60 horses. The ammunition for the siege-battery is 250 rounds per gun. The breech-loading principle was adopted in a clumsy way at the very outset of cannon construction. John Owen first cast brass cannon in England in 1535, and a year or two later they were manufactured in Scotland; but no long guns for firing hollow projectiles at long range by direct fire were known until Colonel Bomford, of the U. S. Ordnance Department, invented a cannon in 1812 called a "Columbiad," which proved very successful. Iron in some form is the sole metal in use for heavy artillery; cast-iron is used for smooth-bore guns and for rifled guns in the United States. Palliser invented a gun with a steel interior tube, strengthened by an exterior casting of iron; and his system became very popular in England; but the inventions of Sir William Armstrong, improved by those of Fraser, proved far superior, and have been generally adopted. Russia, Germany, and other nations have adopted the Krupp system with heavy forgings of steel ingots.

The defense of war-ships with iron armor has caused an increase in the size, weight, and calibers of sea-coast and naval cannon, and the whole method of gun-construction has been altered. Armstrong was the first in England to see the necessity of a change, and his method was improved by Whitworth, Fraser, Palliser, Blakely, and others. Francis Krupp of Essen, Prussia, is the inventor of a new method which proved so successful that it has been introduced in Germany, Russia, Austria, Belgium, and Spain. The body of the gun is fabricated from a solid ingot of low steel worked under heavy steel hammers, and is strengthened by three or more steel tubes shrunk upon the central tube of the gun, the last ring, or tube inclosing the breech, being forged in one piece with the trunnions, without a weld. The rings have various lengths, and the gun is diminished in thickness towards the muzzle, not by tapering, but by being turned with concentric steps of diminished heights. Krupp makes all his projectiles and gun-carriages of steel. In the United States, Rodman, Dahlgren, and Parrott have devoted themselves to the art of gun-construction. The Rodman gun is of cast-iron; it is cast hollow and cooled from the inside, the exterior being in the mean time kept from rapid cooling by fires built around the gun in the casting-pit. The Dahlgren gun is of iron cast solid, and cooled from the exterior, very thick at the breech up to the trunnions, then diminishing in thickness to the muzzle. The Parrott gun, like the Rodman, is of cast-iron, cast hollow, cooled from the inside, and strengthened about the chamber by an exterior tube of wrought-iron bars spirally coiled and shrunk on. It has been suggested that a Rodman gun lined with wrought-iron on Palliser's system would prove a highly effective weapon.

The manner of placing artillery and its employment must be regulated by its relative importance, under given circumstances, with respect to the action of the other arms. In the defensive, the principal part is usually assigned to the artillery; and the positions taken up by the other arms will, therefore, be subordinate to those of this arm. In offensive movements the reverse generally obtains. In defensive positions the security of the batteries is of the last importance. Unless the batteries are on points which are inaccessible to the enemy's cavalry and infantry, they must be placed under the protection of the other troops, and be outflanked by them. As in the defensive, we should be prepared to receive the enemy on every point; the batteries must be distributed along the entire front of the position occupied, and on those points from which they can obtain a good sweep over the avenues of approach to it; the guns being masked, when the ground favors, from the enemy's view, until the proper moment arrives for opening their fire. The distance between the batteries should not be much over 600 paces; so that by their fire they may cover well the ground intervening between them, and afford mutual support; the light guns being placed on the more salient points of the front, from their shorter range and greater facility of maneuvering; the heavier guns on the more retired points. Guns of various caliber should not be placed in the same battery. A sufficient interval should also be left between batteries of different caliber, to prevent the enemy from judging, by the variations in the effect of the shot, of the weight of metal of the batteries. Those positions for batteries should be avoided from which the shot must pass over other troops to attain the enemy. And those should be sought for from which a fire can be maintained until the enemy has approached even within good musket-range of them. Where the wings of a position are weak, batteries of the heaviest caliber should be placed to secure them. A sufficient number of pieces—selecting for the object in view horse-artillery in preference to any other—should be held in reserve for a moment of need; to be thrown upon any point where the enemy's progress threatens danger; or to be used in covering the retreat. The collection of a large number of pieces in a single battery is a dangerous arrangement, particularly at the outset of an engagement. The exposure of so many guns together might present a strong inducement to the enemy to make an effort to carry the battery; a feat the more likely to succeed, as it is difficult either to withdraw the guns or change their position promptly after their fire is opened; and one which, if successful, might entail a fatal disaster on the assailed, from the loss of so many pieces at once. In the outset of offensive movements, good positions should be selected for the heaviest pieces, from which they can maintain a strong fire on the enemy until the lighter pieces and the columns of attack are brought into action. These positions should be taken on the flanks of the ground occupied by the assailant, or on the center if more favorable to the end to be attained. In all cases, wide intervals should be left between the heavy batteries and the other troops, in order that the latter may not suffer from the return-fire which the assailed will probably open on the batteries. For the same reason, care should be taken not to place other troops behind a point occupied by a battery, where they would be exposed to the return-fire of the assailed; when this cannot be avoided, the troops should be so placed as to be covered by any undulation of the ground, or else be deployed in line to lessen the effects of the shot. The artillery which moves with the columns of attack should be divided into several strong batteries, as the object in this case is to produce a decisive impression upon a few points of the enemy's line by bringing an overwhelming fire to bear upon these points. These batteries should keep near enough to the other troops to be in safety from any attempts of the assailed to capture them. Their usual positions will be on the flanks and near the heads of the columns of attack; the intervals between the batteries being sufficient for the free maneuvers of the other troops, in large bodies. The maneuvers of these batteries should be made with promptitude, so that no time may be lost for the action of their fire. They should get rapidly over unfavorable ground to good positions for firing, and maintain these as long as possible; detaching, in such cases, a few pieces to accompany the columns of attack. In all the movements of the batteries, great care should be taken not to place them so that they shall in the least impede the operations of the other troops. See *System of Artillery.*

ARTILLERY COLORS.—In the United States army each regiment of Artillery has two silken Colors. The first, or the National Color, of stars and stripes, as described for the garrison flag. The number and name of the regiment are embroidered with gold on the center stripe. The second, or Regimental Color, is yellow, of the same dimensions as the first, bearing in the center two cannon crossing, with the letters U. S. above and the number of the regiment below; fringe, yellow. Each Color is six feet six inches fly, and six feet deep on the pike. The pike, including the spear and ferrule, is nine feet ten inches in length. Cords and tassels, red and yellow silk intermixed. See *Colors.*

ARTILLERY CORPS.—The larger weapons, before the invention of gunpowder, were sometimes called *engines of war*, sometimes *artillery*, and were worked by strong and rough soldiers, who needed no particular apprenticeship to that art. When, however, large balls of iron came to be propelled by the irresistible force of gunpowder, a great revolution gradually took place, though garrison-guns and siege-guns were improved more rapidly than field-guns. Nevertheless, field-guns changed the whole aspect of military tactics; for it became necessary that an army should form in order of battle at a much greater distance from the enemy than in older times. And when the cannon were made more rapidly movable, so did tactics vary. Gradually a body of men were set apart to study the force and action of gunpowder, the flight and range of projectiles, the weight and strength of cannon, and the maneuvering of heavy masses. The French were the first to make these researches; after them, the English; and still later, the Germans. During the Thirty Years' War an important step was taken in Germany—that of including the artillerymen, who were till then a sort of guild, as a component in the Regular Army. Gustavus Adolphus in Sweden, Frederick II. in Prussia, and Napoleon I. in France, all attached a very high degree of importance to the artillery as an arm of the service. After the great wars in the beginning of the present century nearly all the States of Europe formally recognized the artillery as the third great branch of military service (next after the infantry and cavalry); indeed, some of them, including Russia and Sardinia, have shown a tendency to elevate it to the first rank.

Artillery Corps, or artillerymen, are divided into land-artillery and marine-artillery. The land-artillery is divided into field, coast, garrison, and siege artillery. The field-artillery is subdivided into horse and foot. There are also the special appellation of reserve, light, and heavy artillery. In most European States the artillerymen are divided into regiments, battalions, brigades, and companies; but, in Britain the whole form one enormous regiment, which is expanded or contracted according to the exigencies of the service. When military men speak of *the* field-artillery they usually include cannon, carriages, horses, ammunition, and stores of every description, as well as the artillerymen. The distinction between heavy and light artillery depends on the size of the cannon and the weight of the shot and shell propelled from them. For obvious reasons the construction of very large field-guns is avoided. Military men are not quite agreed as to the precise figures; but there is a general concurrence in opinion that a well-appointed field-force should have two or three artillery guns to every 1000 infantry, and five or six horse-artillery guns to every 1000 cavalry. The proportion is necessarily affected by the kind of country and the amount of available transport. During the Peninsular War, Wellington had seldom more than 1 gun to every 1000 soldiers; when he entered France he had 3 to the 1000. Napoleon preferred 2 per 1000, with a larger supply of ammunition than had before been deemed necessary; and many foreign governments followed his example. Experienced officers in the British artillery have laid it down as a useful rule that an army of 60,000 men, comprising 50,000 infantry, 7500 cavalry, and 2500 artillery, should have 100 pieces of ordnance—viz., 30 for horse-artillery, 54 for foot-artillery, and 16 in reserve. See *Honorable Artillery Company*.

ARTILLERY HORSES.—Horses for artillery service should be not less than nine hundred nor more than twelve hundred pounds; age not less than five nor more than eight years; forehead wide; shoulders broad enough to support the collar, but not too heavy; forelegs short, straight, and well under the horse; chest broad and deep, barrel large and increasing from girth to flank; withers elevated, back short and straight, loins and haunches broad and muscular; hind-legs short, hocks well bent and under the horse; feet rather large. Special care must be taken that the withers are not too sharp, and that the horse is neither sway-backed nor roach-backed. In time of war horses should not be accepted under six nor over ten years of age; young animals, as a rule, are not able to stand the exposure of a campaign. Each horse must be well broken to harness; and in each battery horses of the minimum size and weight should never exceed one third of the whole number. The load allotted to an artillery horse is less than that usually drawn by a horse of commerce, for the reason that allowance must be made for bad roads, bad forage, rapid movements, and forced marches. They are as follows: Light-artillery horse, 700 lbs., including carriage; heavy field-artillery, 850 lbs.; siege-artillery, 1000 lbs. The above is based on the rapidity of movement required in the different services. An ordinary draught-horse can draw 1600 lbs. 23 miles in a day. Usually a horse can draw seven times as much as he can carry; hence all material of war should be transported on carriages if practicable. The average march for artillery on good roads is from fifteen to twenty miles per day. With rare exceptions the walk is the invariable gait. Long marches or expeditions should be begun moderately, particularly with horses new to the service. Ten or twelve miles a day is enough for the first marches, which over good roads may be increased to twenty or twenty-five miles when necessary, after the horses are inured to their work. The care of horses on the march is one of the most important duties of an artillery officer; by *constant attention* many horses may be kept in serviceable condition which would otherwise be disabled for months. Reveille, ordinarily, should not be sounded on the march before daylight, as horses rest better from midnight until dawn than at other times. A halt of from five to ten minutes is made at the end of every hour, for the purpose of adjusting harness, tightening girths, etc. When troops march for the greater part of the day, a halt of from twenty to forty-five minutes should be made about noon. The march is usually in column of sections; when practicable it will be in column of platoons at closed intervals; but the front of the column must not be frequently diminished or increased, as this unavoidably adds to the fatigue of the horses, particularly of those in rear. When distances are lost in column, they must never be regained by taking the *trot;* no practice is more fatiguing to horses and more injurious to their shoulders than the alternate trotting and walking so often seen at the rear of artillery columns. The walk will be quickened as much as possible by such carriages as have lost distance, and it is the duty of the Captain to have the gait of the leading guide slackened, or the column halted, so that they can close up. See *Draught Animals*.

ARTILLERY LEVEL.—An instrument adapted to stand on a piece of ordnance and indicate by a pendulous pointer the angle which the axis of the piece bears to the horizontal plane. By its means any required angle of elevation is given to the piece.

ARTILLERY MASS.—A concentration of artillery with mobility. It should combine with great mobility a powerful fire, which can be concentrated on some definite point of an enemy's line to be broken through. *Masses of Artillery* are usually employed after troops have been engaged for some time and the weak points of the enemy's lines have been ascertained.

ARTILLERY PARK.—A collective name given to the whole of the guns, carriages, ammunition, and other appurtenances essential to the working of siege or field-artillery. Besides reserve guns and carriages, there belong to it the ammunition-wagons, as well for the infantry and cavalry as for the artillery, the implements and materials necessary for repairing and completing equipments, harness-stores, field-forges, laboratories, and (in some armies) transport and provision wagons. The *personnel* of a park of artillery consists of artillery officers, non-commissioned officers, and artillerymen; besides a large number of smiths, wheelwrights, saddlers, armorers, drivers, and other mechanics and laborers. Sometimes the term is applied to the place selected, as well as to the vast military stores collected there.

ARTILLERY PRACTICE.—Siege-artillery is generally used against fixed objects on land; the target should therefore be placed on land. The range for the 4.5-inch gun should be about 2000 yards, and for this distance a target 12 feet square would be suitable. It is made of canvas, or of light boards nailed to uprights planted in the ground, and is whitewashed. A circular bull's-eye 4 feet in diameter is painted in black in the center of the target. About 100 feet diagonally in front of the target a pit of suitable size for the marker is dug, the earth being thrown upon the side towards the piece. It adds greatly to the security of the marker to have splinter-proof covering for the pit. The marker is provided with a disk, about a foot in diameter, made of sheet-iron or thin board, one side of which is painted black, the other white, and provided with a staff sufficiently long to enable him to point the disk to any part of the target. The marker should be accompanied by a flagman skilled in signaling, and provided with a white or red flag, such as are supplied by the Signal Bureau. At the piece is another flagman similarly provided. Where it is possible, a hill, situated two or three hundred yards beyond the target, is advantageous for arresting the projectiles. Cleared space beyond the target is preferable to woods.

Firm ground is selected for the gun-platform, which is laid with care and precision. The distance to the target is ascertained either by direct measurement, with the telemeter, or by triangulation. Previous to going out to fire, the Instructor should prepare a memorandum-table of elevations for each kind of projectile to be used, and the time to which fuses are to be cut for shells. The time of flight is determined by means of a stop-watch, and the distance at which shells burst by the Boulongé telemeter. Care and deliberation are exercised in loading and pointing. When the piece is ready to be fired, a signal is made by the flagman at the piece to the marker and flagman at the target, who then screen themselves in the pit. As soon as the projectile strikes, the flagman at the pit raises his flag and the marker proceeds, in case it has struck the target, to cover the hole with his disk; when a shell has been fired, the flagman signals whether it has burst short of or beyond the target. An observer at the piece, with a glass, or even with the naked eye, can see upon which side of the target the projectile passes, and can form an approximate estimate of the distance to the right or left.

From the data thus obtained, errors of pointing and of cutting the fuse may be corrected for succeeding shots. A complete record of each fire is kept and entered on a blank form furnished by the Ordnance Department. This record, besides giving a description of the piece, contains the kind and weight of the projectile, the kind of powder and the weight of charge, the elevation and the time of flight, the kind and length of fuse, and the position of the piece, whether above or below the level of the target. In the column of remarks is entered whether the projectile struck the target, and if so, where; or if it missed, to which side, and how far; whether it fell short or went beyond; whether the shell exploded short, beyond, or did not explode. The direction of the wind, with reference to the line of fire, and its strength are noted. Those engaged in the firing, particularly the officers, should examine and study the ground about the target, observing the effect produced by the striking of the shot; whether they penetrated or ricocheted; the depth of penetration, the character of the craters formed by bursting shells, and of the furrows made by glancing projectiles. This information is useful when constructing works of shelter against an enemy, and in the attack upon and demolition of his works.

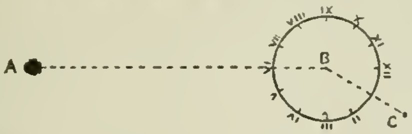
When the allowance of ammunition that may be expended admits of it, firing at a horizontal target should be practiced. The object of this kind of firing is to group the shots as closely as possible on the ground about the target. The rectangular space inclosed by the shots is called the polygon of fire. In actual service, the purpose of such fire is to reach an enemy sheltered behind works or some intervening object, as hills or woods. This is accomplished by the *drop* of projectiles fired at long range, or at short range by reducing the charge and giving high elevation. Skill in this, the most difficult kind of firing, can be acquired only by practice. To obtain the *center of impact*, the target, if an upright one, is divided into four parts by a horizontal and a vertical line passing through the center of the bull's-eye; if the target is horizontal, as for mortar-firing, one line is drawn as the trace of the plane of fire, and the other throught the center of the target at right angles to it. The distance in feet of each shot is measured from these lines as co-ordinates, and recorded in a table; as, *above* or *below* the horizontal line, and to the *right* or *left* of the vertical line. The table is of the following form:

No. of Shot.	Distance from Co-ordinates.				Distance from Center of Impact.			
	Vertical.		Horizontal.		Vertical.		Horizontal.	
	Above	Below.	Right.	Left.	Above	Below.	Right.	Left.
1....	3	..	2	..	4	..	1.6	...
2....	..	4	..	5	..	3	...	5.4
3....	.	6	4	..	..	5	3.6	...
4 ...	4	.	..	2	5	..	...	2.4
5....	..	2	3	.	..	1	2.6	...
	7	12	9	7	9	9	7.8	7.8
	5 + 5 = 1		2 + 5 = 0.4		18 + 5 = 3.6		15.6 + 5 = 3.12	

The algebraic sum of the distances in each direction, divided by the number of shots, gives the position of the center of impact in this direction. In the above example, the position of the center of impact is 1 foot below and 0.4 foot to the right of the center of the target. To obtain the mean deviation it is necessary to refer each shot-hole to the center of impact as a new origin of co-ordinates; and this is done by subtracting the tabular distance from the distance of the center of impact if both be on the same side of the center of the target, and adding them if on different sides. The sum of all the distances thus obtained in one direction, divided by the number of shots, gives the mean deviation in that direction; which in the present case is 3.6 feet vertically and 3.12 feet horizontally. The foregoing affords a measure for the accuracy of fire of the piece and projectile, but it does not afford so good a test of marksmanship as the *string*, or sum of the distances of the shots from the point aimed at. Target-practice with the 8-inch siege-howitzer is conducted in the same manner as for siege-guns, but the distance should not exceed 1200 yards, and the target need not be over 10 feet square. Direct, ricochet, and rolling fire should each be practiced with this piece. To observe the flight of canister, it is best to fire it over smooth water, with an elevation not exceeding two degrees.

The target for the 10-inch siege mortar should be about 1500 yards from the piece. The best form for the target is that of a square, inclosing the general trace of a field-work. The sides of the square should be about 100 yards, and the trace marked by stakes driven at distances of about 10 feet apart. A large empty cask or box, placed upon a post in the center of the figure, and whitewashed, serves as a point to aim at. At a distance of not less than 150 yards to the right or left of the target is constructed a strong bomb-proof for the marker and flagman. The marker is provided with a number of small stakes which, to make them more conspicuous, have attached to them a piece of white or red stuff. When a shell strikes the ground, the marker notes the place with a stake, marking it with a number corresponding to the number of the shot. The rules governing the flagman at the bomb-proof and at the piece are the same as those already given for the siege-gun. A convenient method of notifying those at the mortar as to the points at which the shells strike is to describe around the center of the target a circle with a radius of about twenty-five yards. Divide this circle into twelve equal parts, which mark conspicuously with stakes, being careful to place one of the divisions on the prolongation of the line passing through the mortar and the center of the target. Call this point XII, and number the others around to the right similar to the dial of a clock.

Suppose the shell falls at the point C (see figure), on the line passing through the center B and I, and at a distance of, say, twenty yards from the center. The marker steps or otherwise measures this distance, and signals to the piece "*One*"—"20." Those at the piece, referring to a similar diagram made upon *diagram* paper, ascertain at a glance the approx-



imate point at which the shell struck the ground. Firm ground is selected for the platform, and the distance to the target is determined as for siege-guns, as is likewise the time of flight of shells and the distance at which they explode. In order to economize shells, charges sufficient only to blow out the fuse are used, and the shells are afterwards collected. After the firing is completed, the distance from each point where a shell fell to the center of the target is measured, and, if desirable, a diagram made of the target, showing the position of each shot.

Previous to going out to fire, the Instructor should prepare a memorandum range-table, so that the first shots may be approximately accurate. Subsequent shots should be rectified with care; the tendency is always to overdo the correction; as, for instance, when the shell falls short, the addition given to the charge will most likely send it far beyond; or, should it fall to one side, the correction given to the direction will probably be so great as to cause it to fall a still greater distance to the other side. Under the most favorable circumstances, mortar-firing, as compared with firing from other kinds of cannon, possesses, inherently, a considerable degree of inaccuracy, and in making corrections care should be observed to discriminate between this and faulty gunnery. When practicable, the charges of powder should be weighed; if *measured*, uniformity should be observed as to the manner of doing it, so that all shall be shaken down in the measure, or all measured loosely. The platform should be tested frequently, to see that it does not settle unevenly. The shells should be weighed and marked with chalk, and in firing them care should be observed to commence with the lightest and go up to the heaviest, or *vice versa*. This enables the corresponding variation of the charge to be made with a greater degree of certainty. Target-practice with the 8-inch mortar is conducted as just explained for the 10-inch.

Target-practice with the Coehorn mortar is similar to the foregoing; but the distance to the target should not exceed 1000 yards, and the target may be smaller. As this piece can be moved from place to place with ease, and requires nothing more than level and firm ground for a platform, the distance to the target should be varied, thus affording practice such as frequently occurs in war-service. Sea-coast mortars are chiefly used against shipping in the defense of harbors; a floating target should therefore be used. Any floating object, as an empty cask or a spar, anchored to mark the spot, suffices. The distance to the target should be about 3000 yards. The practice is conducted in the same manner as for the 10-inch siege-mortar, except that for the purpose of determining the points of fall, or of explosion of the shells, plane-tables are employed in the manner hereafter explained. As the shells are not recovered after being fired, bursting-charges may be used.

Sea-coast guns are chiefly used against ships, and are fired over water; hence the target should be floating. For the 15-inch smooth-bore and the 8-inch and Parrott rifles it should be moored at a distance of about 3000 yards; for the 10-inch smooth-bore the distance should be about 2000 yards. Plane-tables are employed for the purpose of recording the striking-points of shots or the bursting-distance of shells. The tables are stationed one at each extremity of a line, the length of which is accurately determined either by actual measurement or by triangulation from a base-line, the measurement of which has been made with care and precision. At every post mounting heavy artillery a base-line should be so determined and permanently marked, to be used for the various requirements of artillery-firing. About 1000 yards is a suitable length for it. The plane-tables are placed so as to have a clear view of the target, of each other, and of the guns. They should, furthermore, be so placed that the lines joining them with the target will intersect at as near a right angle as possible This enables the position of the shot to be determined and plotted with greater accuracy than would be the case did the lines intersect with a very acute angle. The direction of the wind is determined by a vane at the piece. The most convenient and reliable method of noting it is by referring it to the dial of a watch held in such a position that the line passing through VI and XII will be parallel to the line of fire with the XII towards the target. The *direction* is that from which the wind comes. When coming directly from the front, it is noted as "*twelve o'clock*"; when from the rear, as "*six o'clock*"; when from the right, as "*three o'clock*"; when from the left, as "*nine o'clock*"; and when from intermediate points, in a similar manner. The velocity of the wind is determined by an anemometer. When it is practicable to establish telegraphic communication, all of the foregoing operations, so far as signaling is concerned, are greatly facilitated.

The target for the Gatling gun is made of light canvas or ordinary muslin, and is in four or more sections, each section being 8 feet long by 6 feet high. The canvas is nailed to a strong light frame, the uprights of which extend about 12 inches below the canvas in order that they may be set in the ground. Practice should commence at 200 yards and the distance be increased up to 1000 yards, or more. At the first distance a single section of the target is sufficient, and as the distance increases other sections will be added. Smooth, level, and firm ground should be selected for the gun to stand upon. See *Floating Target* and *Target*.

ARTILLERY SCHOOL.—A special school for instruction and training in artillery. The first school for artillery instruction was established by the Venetians in the beginning of the sixteenth century. Soon afterwards Charles V. established similar schools at Burgos and in Sicily. The French founded a school of practical artillery in 1675; and in 1679 they added to it a theoretical school at Douai. At present France has no fewer than seven such establishments. Saxony had an artillery school in 1766; but the other German States were more tardy in this work. In Prussia the artillery and engineer schools are combined, but in most of the European States a separation between these two arms of the science is made. In most schools of artillery the officers' studies comprise mathematics, as much of physics and chemistry as is necessary to the duties of the artillerist, field and permanent fortification, garrison warfare, field-tactics, military history and topography, military surveying and sketching, drawing from the model, etc. The practical exercises include the serving and firing of guns and mortars, the laying out and constructing of field-batteries, and the operations of the laboratory and artillery workshop.

The headquarters for artillery instruction in England are at Woolwich. A *Royal Military Academy* was established there in 1741, to impart professional instruction to the Artillerists and Engineers belonging to the Royal Army. The East India Company sent their Artillery Cadets to this academy from the year 1798 to 1810; but afterwards, until 1861, they maintained a separate establishment at Addiscombe (which, however, was not wholly for artillery). At the present day the students in the academy are recruited by fair open competition. They enter between the ages of seventeen and twenty; and they remain two years, or such longer time as may fit them to pass an examination for the Royal Artillery or Engineers. The sons of military officers are admitted on lower terms than those of other persons. The financial control is under the Secretary of State for War; but the Commander-in-Chief regulates the discipline and internal arrangements. There are twenty-two Professors and Instructors of various kinds. Besides this Royal Military Academy, there is at Woolwich a *Department of Artillery Studies*, for the instruction of junior officers of artillery, and for facilitating their visits to the fortifications and public works of foreign countries. There is also a *Select Committee*, whose duties are not so much educational as experimental; it is a small establishment for examining and reporting on the numerous inventions relating to artillery brought before the War Office. The School of Gunnery at *Shoeburyness*, subordinate to the headquarters of the artillery at Woolwich, is for experiments upon ordnance, gunpowder, and projectiles, and to exercise young artillery officers in the practical and mechanical duties of their profession.

An Artillery School was established in the United States in 1823 at Fortress Monroe, but discontinued six years later. The School was re-established in 1858, and was again closed when the war began in 1861. Near the close of 1867 it was again established. It is commanded by a Colonel of Artillery, assisted by a Lieutenant-Colonel and a Major. The instruction is both theoretical and practical; and each of the Artillery Regiments in the Regular Army has one foot-battery at the School, the officers of the several batteries being the Instructors. The term of instruction at present is two years for officers and one year for enlisted men. The course of studies for enlisted men comprises mathematics, geography, history, tactics, and penmanship. The course of practical exercises comprises as much of that appointed for the school for officers as is essential for enlisted men.

The following is a summary of the Course of Instruction pursued at the United States Artillery School:

ARTILLERY TRAIN.—The guns which accompany an army are assembled into an *Artillery Train*, containing pieces of different weights and calibers, to meet the various requirements of a campaign; and a certain number of men with officers are attached to the train, some to serve the guns, others to move and mount them and effect repairs.

ART OF WAR.—War, as usually defined, is a contest between Nations, States, or parts of States, carried on by force. Wars, from the causes for which they are waged, or which have produced them, are called Wars of Opinion, Wars of Conquest, Civil Wars, Wars of Rebellion or Insurrection, etc. In a military point view wars are usually classed as defensive or offensive wars. The Armies of a Nation entering the domains of another for the purpose of making war upon it carry on an offensive war, while for the latter nation the war is defensive. To the Science of War belongs a study of those principles which govern all the operations of war, and which are deduced from a study of the history of wars conducted by great Military Commanders. The Art of War is the practical application of these principles by a General in command of an army. The Art of War is divided into branches, which by most military authorities are classed as follows: (*a*) Statesmanship in relation to war; (*b*) Strategy; (*c*) Grand Tactics; (*d*) Logistics; (*e*) Engineering; (*f*) Minor Tactics. The first subject belongs purely to the political questions involved in the war, which clearly do not come within the scope of a military work. There is a subject which most clearly is a branch of the Art of War, and which of late years has become of the first importance, owing to the short duration of recent wars, viz., the Organization of Armies. We have lately seen that power which has developed the system of organization to the greatest extent and most highly perfected it conquer in two wars of great magnitude in a wonderfully short period. That Nation which adopts the most perfect plan of organizing its Armies will have a great advantage in future wars; for, as time is the most important element in military operations, the

<table>
<tr><th rowspan="2">Month.</th><th colspan="2">First Year.</th><th colspan="2">Second Year.</th></tr>
<tr><th>Studies.</th><th>Practice.</th><th>Studies.</th><th>Practice.</th></tr>
<tr><td>May.</td><td>May 10th to June 10th. Mathematics; preliminary instruction in Engineering; Signaling and Telegraphy.</td><td rowspan="3">May 10th to July 1st. * Drill, viz.: The Service and Mechanical Maneuvers of the various kinds of pieces, laying platforms for siege-guns and mortars; firing-practice with field- and siege-guns, howitzers, and siege and sea-coast mortars.</td><td rowspan="3">Artillery Tactics and the Science of Artillery.</td><td rowspan="3">Artillery Science.
* Drill.</td></tr>
<tr><td>June.</td><td rowspan="2">June 10th to July 1st. Preliminary instruction in Artillery Science; Signaling and Telegraphy.</td></tr>
<tr><td>July.</td></tr>
<tr><td>August.</td><td colspan="2">July 1st to September 1st.
Artillery Firing-practice.
* Drill.</td><td colspan="2">July 1st to September 1st.
Artillery Firing-practice.
* Drill.</td></tr>
<tr><td>September.</td><td rowspan="4">Sept. 1st to Dec. 22d.
Engineering,—
including Examination in same.</td><td rowspan="4">Sept. 1st to Dec. 22d.
Engineering,—
including Examination in same.
* Drill.</td><td rowspan="4">Sept. 1st to Jan. 15th.
Military History, Geography, Infantry and Grand Tactics,—including Examination in same.</td><td rowspan="4">Sept. 1st to Jan. 15th.
Infantry, Applied Tactics.
* Drill.</td></tr>
<tr><td>October.</td></tr>
<tr><td>November.</td></tr>
<tr><td>December.</td></tr>
<tr><td>January.</td><td rowspan="4">Jan. 5th to Sept. 1st, 2d year.
Artillery Tactics and the Science of Artillery.</td><td rowspan="4">Jan. 5th to Sept 1st, 2d year.
Artillery Science.
* Drill.</td><td rowspan="3">Jan. 15th to April 15th.
Law and Military Administration, — including Examination in same.</td><td rowspan="3">Jan. 15th to April 15th.
Military Administration.
* Drill.</td></tr>
<tr><td>February.</td></tr>
<tr><td>March.</td></tr>
<tr><td>April.</td><td>April 16th to May 1st:</td><td>Examination.</td></tr>
</table>

* This practice continues during the term of two years, daily, excepting Saturdays and Sundays, and such periods as are occupied in other practical exercises. Infantry-drill, and target-practice with small arms, at such times as ordered by the Commandant.

See *Military Academy*.


ASIA
SCALE OF MILES
0 200 400 600 800 1000
ATLANTIC OCEAN
ARCTIC OCEAN
EUROPE
RUSSIA
SIBERIA
RUSSIAN EMPIRE
CHINESE EMPIRE
MONGOLIA
MANCHOORIA
CHINA
TIBET
TURKESTAN
PERSIA
AFGHANISTAN
BELOOCHISTAN
ARABIA
INDIA
BURMAH
SIAM
TURKEY IN ASIA
AFRICA
MEDITERRANEAN SEA
RED SEA
ARABIAN SEA
INDIAN OCEAN
BAY OF BENGAL
CHINA SEA
YELLOW SEA
SEA OF JAPAN
SEA OF OKHOTSK
JAPAN ISLANDS
PHILIPPINE ISLANDS
BORNEO
CELEBES
JAVA SEA
BANDA SEA
ARAFURA SEA
PACIFIC OCEAN
N. AMERICA
AUSTRALIA
CEYLON
FORMOSA
HAINAN
Behring Strait
Longitude East of Greenwich
EQUATOR

country which first places a superior number of disciplined troops in the field is enabled to assume the offensive at once, and to advance against an enemy unprepared to meet it. It is, therefore, a subject which will in future demand the first consideration and the most thorough study; for, owing to the facility with which armies are now moved to the place of contest, that nation which is more fully prepared has great odds in its favor at the beginning of the war, and a few decisive actions at this time will usually be favorable to it and go far toward ending the conflict.

For these reasons, then, the Art of War should more properly be subdivided into the following branches, viz.: (*a*) The Organization of Armies; (*b*) Logistics; (*c*) Strategy; (*d*) Engineering; (*e*) Tactics. The Organization of Armies is the building up necessary for the application of the principles of strategy to them. Logistics is the art of moving and supplying armies. Strategy is the art of directing armies upon the theater of war. Engineering is the art of disposing troops and making arrangements of obstacles by means of which an inferior force may successfully resist the attacks of a superior force; and also the art of overcoming and removing all obstacles placed in the way by an opposing force. The following are the duties of Engineers of an army: the construction and maintenance of field-telegraphs, the construction of fortifications, the conduct of engineering operations at sieges, mining, bridging, surveying, reconnoitering, opening and making roads, choosing positions, sketching ground, etc. The details of these duties will be found in the different Manuals and Text-books of Engineering. Tactics is the art of putting into execution the projects of Strategy. An intimate knowledge of all these branches is absolutely necessary in order to be a great and successful General. The formation of a plan, that is, deciding the nature of the war that will be waged; determining the objects to be attained, and the best manner and means of attaining them; or, in other words, outlining the general features of a campaign, belong to Strategy. The execution of the plan decided upon belongs to Tactics. The country in which the opposing armies can come into collision is the province of Strategy. The province of Tactics is the field of battle. The principles of war cannot be violated with impunity. These principles are fixed and are determined from the narrative of operations conducted by successful Generals. A study of military history is then necessary for a proper understanding of the principles of war; and as in all other professions, so in war, he who is most proficient in the lessons as taught by the masters of the art will be most successful.

The duties of each arm of the service overlap and blend into one another, and the higher the grade an officer attains, the more requisite it is that he should be acquainted generally with the duties of those arms of the service to which he himself does not belong. By this means alone can we hope to obtain that intelligent co-operation, that harmonious working of all branches of the service together, which makes a perfect machine out of the various elements comprising an army, and at the same time gives the surest guarantee of success. In armies, as elsewhere, there is a tendency for every one to think his own branch, that which he has studied most and knows best, the most important. Such feelings are very natural, and in the lower grades often do much good; but as men rise in the service it is desirable that they should know something of the duties of other branches, and the difficulties others have to contend with. Such knowledge tends to produce cordiality and forbearance. Cavalry officers falling into command of mixed forces will not then expect their infantry to gallop, infantry officers will not seek to bind the cavalry to the pace of their infantry. A knowledge of the capabilities of other arms will enable officers to use those arms to the best advantage as occasion offers. It should, however, be borne in mind that it is impossible to lay down fixed rules of action. Nearly every military regulation should be followed by the words "according to the ground and according to circumstances." Rules are but guides, which must be intelligently, not blindly, followed. Practice and experience alone can decide many points; practice and experience alone can give the power of applying rules; but theory, by which is really meant the experience obtained by others, is not the less important and valuable. Principles are but guides, which must be revised, examined, and verified after each war, after each discovery that may be brought to bear on the military art. The great success of Gustavus Adolphus, Frederick, Marlborough, Napoleon, Wellington, Von Moltke, are but due to careful consideration and appreciation of the effects of various discoveries on the Art of War. There is no finality in the Art of War.

ARX.—In the ancient military art, a fort, castle, etc., for the defense of a place.

ARZEGAGES.—Batons or canes with iron at both ends. They were carried by the Estradiots, or Albanian cavaliers, who served in France under Charles VIII. and Louis XII.

ASAPES.—An inferior class of Turkish soldiers employed in sieges to work in intrenchments and perform other pioneer duty.

ASHLAR—ASHLER.—Building-stone squared and hewn, as distinguished from rubble, or rough stones which are used as they come from the quarry without being dressed. Ashlar is laid in regular courses in fortification, and is of various kinds, according to the style of working that side of the stone which is to form the facing of the wall. Thus there are *tooled ashlar*—the marks of the tooling being either *random* or in *grooves*; *polished ashlar*, in which the face of the stone is rubbed smooth; and *rustic ashlar*, in which only the joints are accurately hewn, the face of the stone being left projecting irregularly. Quarriers apply the term ashlar to squared stones before being hewn. In old documents the term appears under a variety of forms, such as *achlere*, *ashelar*, *asture*, and *estlar*.

ASKERI MOHAMMEDIZE.—A name given to the Turkish regular troops organized according to modern tactics.

ASPECT.—An army is said to hold a menacing aspect when by advanced movements or positions it gives the opposing enemy cause to apprehend an attack. A country is said to have a military aspect when its general situation presents appropriate obstacles or facilities for an army acting on the offensive or defensive. An army is said to have an imposing aspect when it appears stronger than it really is. This appearance is often assumed for the purpose of deceiving an enemy, and may not improperly be considered as a principal *ruse de guerre*.

ASPHALT—ASPHALTUM.—The name given to a bituminous substance of a solid consistence. It probably owes its origin to vegetable matter which has been subjected to a slow process of decomposition or decay, resulting in the production of a bituminous coal, from which, by volcanic agency, the asphalt has been distilled and diffused over the neighboring district. The largest natural deposit of asphalt is in the Island of Trinidad, where the plain known as the *Pitch Lake* is found. The asphalt from Trinidad is largely used for ships' bottoms, and is reputed to kill the teredo or borer, which proves itself so very destructive to the wood of ships in tropical regions. Asphalt is also found on the shores of the Dead Sea in large quantity, and is known to the Arabs by the name or *Hajar Mousa*, or *Moses' Stone*. It likewise occurs in South America at Coxitambo near Cuenca, in Alsace and other parts of the European Continent, in East Lothian and Fifeshire (Scotland), in Shropshire, etc. During the manufacture of coal-gas much tarry matter is evolved from the retort, and is received in the coolers or condensers. If this tar be subjected to partial distillation, naphtha and other volatile matters escape, and an artificial asphalt is left behind, which possesses the principal properties and can be employed for the majority of purposes to which native asphalt is applied. The various kinds of asphalt have a pitchy odor, are of a black or dark-brown color, but do not soil the fingers; are insoluble in water, sparingly soluble in alcohol; but are in great part dissolved by ether, oil of turpentine, and naphtha. *Petroleum*, or *rock-oil*, is a native liquid bitumen, which largely exudes from crevices in rocks in many districts, and is essentially asphalt dissolved in naphtha. The specific gravity of asphalt is very near that of water, ranging from 1000 to 1100. When set fire to, it burns readily with a smoky flame, and is often used in the smaller gas-works as fuel, by being allowed to run very slowly into the furnace-fires. Asphalt, besides being employed for coating the exterior of ships' bottoms, is also used, in a heated condition, for saturating timber which is intended for piles in the construction of breakwaters, river-bridges, and other situations where the combined action of the air, water, and minute animals would soon render ordinary wood rotten and useless. Wooden houses may be preserved in the same manner by a coating of asphalt applied externally; and ground-flooring placed in damp situations is much the better for the spaces between the planks being filled up with asphalt. About 1840 asphalt began to be generally used for foot-pavements, and also for floors of cellars and outhouses. For purposes of this nature it is heated in portable boilers, into which, at a certain stage of the preparation, there is poured a quantity of thoroughly dried sand, gravel, or powdered limestone, which is well mixed with the liquid asphalt. The mixture is then spread on the spot prepared for it, and when cool forms a hard kind of pavement. Of this method of forming footways high expectations were at first formed; but latterly the process of asphalting has gone out of use in England, as it is found not to be so durable as stone, and therefore, in ordinary circumstances, more costly. In Paris, however, asphalting is still extensively practiced in the more spacious thoroughfares. The better kinds of asphalt are used in the manufacture of the black varnish which is employed in forming the enamel which coats the variety of leather known as *patent leather*.

ASPIC.—An ancient piece of ordnance which carried a 12-pound shot; the piece itself was 11 feet long, and weighed 4250 pounds.

ASPIS.—A large round or oblong shield which was used by the heavy infantry of the ancient Grecians.

ASSAS-BACHI.—A superior officer of Janissaries, who was also Administrator of the Police Department in Constantinople, and presided over public executions.

ASSASSINATION.—The law of war does not allow proclaiming either an individual belonging to the hostile army, or a citizen, or a subject of the hostile government, an outlaw, who may be slain without trial by any captor, any more than the modern law of peace allows such international outlawry; on the contrary, it abhors such outrage. The sternest retaliation should follow the murder committed in consequence of such proclamation, made by whatever authority. Civilized nations look with horror upon offers of rewards for the assassination of enemies as relapses into barbarism.

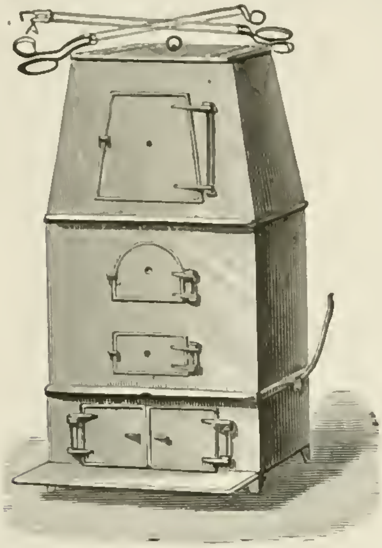
ASSASSINS.—A military order, a branch of the secret sect of the Ismaelites. The secret doctrines of these Ismaelites, who had their headquarters in Cairo, declared the descendants of *Ismael*, the last of the seven so-called Imaums, to be alone entitled to the califate; and gave an allegorical interpretation to the precepts of Islam, which led, as their adversaries asserted, to considering all positive religions equally right, and all actions morally indifferent. The atrocious career of the Assassins was but a natural sequence of such teaching. The founder of these last, Hassan-ben-Sabbah-el-Homairi, of Persian descent, and imbued with the free-thinking tendencies of his country, had, about the middle of the eleventh century, studied at Nishpur, under the celebrated Mowasek, and had subsequently obtained from Ismaelite *Dais*, or religious leaders, a partial insight into their secret doctrines, and a partial consecration to the rank of Dai. But on betaking himself to the central lodge at Cairo, he quarreled with the heads of the sect, and was doomed to banishment. He succeeded, however, in making his escape from the ship, and reaching the Syrian coast, after which he returned to Persia, everywhere collecting adherents, with the view of founding, upon the Ismaelite model, a secret order of his own, a species of organized society which should be a terror to his most powerful neighbors. In 1090 Hassan conquered the Fortress of Alamut, in the Persian district of Rudbar; and continued to increase in strength, intimidating Princes and Governors by a series of secret murders, and gaining possession of several fortified Castles, with their surrounding territories, both in the mountain-range south of the Caspian, in Kuhistan, and in the mountains of Syria (Massiat). The internal constitution of the order, which had some resemblance to the orders of Christian Knighthood, was as follows: First, as supreme and absolute ruler, came the Sheikh-al-jebal, the Prince or Old Man of the Mountain. His vicegerents in Jebal, Kuhistan, and Syria were the three *Dai-al-kebir*, or Grand-Priors of the order. Next came the Dais and Refiks, which last were not, however, initiated, like the former, into every stage of the secret doctrines, and had no authority as teachers. To the uninitiated belonged first of all the Fedavies or Fedais, i.e., the devoted: a band of resolute youths, the ever-ready and blindly obedient executioners of the Old Man of the Mountain. Before he assigned to them their bloody tasks he used to have them thrown into a state of ecstasy by the intoxicating influence of the *hashish* (the hemp-plant), which circumstance led to the order being called Hashishim, or hemp-eaters. The word was changed by Europeans into Assassins, and transplanted into the languages of the West with the signification of murderers. The Lasiks, or novices, formed the sixth division of the order, and the laborers and mechanics the seventh. Upon these the most rigid observance of the Koran was enjoined; while the initiated, on the contrary, looked upon all positive religion as null. The catechism of the order, placed by Hassan in the hands of his Dais, consisted of seven parts, of which the second treated, among other things, of the art of worming themselves into the confidence of men. It is easy to conceive the terror which so unscrupulous a sect must have inspired. Several Princes secretly paid tribute to the Old Man of the Mountain. Hassan, who died at the age of 70 (1124 A.D.), appointed as his successor, Kia-Busurg-Omid, one of his Grand-Priors. Kia-Busurg-Omid was succeeded in 1138 by his son Mohammed, who knew how to maintain his power against Nureddin and Jussuf-Salaheddin. In 1163, Hassan II. was rash enough to extend the secret privilege of the initiated—exemption, namely, from the positive precepts of religion—to the people generally, and to abolish Islam in the Assassin State, which led to his falling a victim to his brother-in-law's dagger. Under the rule of his son, Mohammed II., who acted in his father's spirit, the Syrian Dai-al-kebir, Sinan, became independent and entered into negotiations with the Christian King of Jerusalem for coming over, on certain conditions, to the Christian faith; but the Templars killed his envoys, and rejected his overtures, that they might not lose the yearly tribute which they drew from him. Mohammed was poisoned by his son Hassan III., who reinstated Islamism, and thence obtained the surname of the New Moslem. Hassan was succeeded by Mohammed III., a boy of nine years old, who, by his effeminate rule, led to the overthrow of the order, and was eventually murdered by the command of his son, Rokn-eddin, the seventh and last Old Man of the Mountain. In 1256 the Mongolian Prince Hulagu burst with his hordes upon the hill-forts of Persia held by the Assassins, which amounted to about a hundred, capturing and destroying them. The Syrian branch was also put down about the end of the thirteenth century, but remnants of the sect still lingered for some time longer in Kuhistan. In 1352 the Assassins reappeared in Syria, and indeed they are still reported to exist as a heretical sect both there and in Persia. The Persian Ismaelites have an Imaum, or Superintendent, in the district of Kum, and still inhabit the neighborhood of Alamoot under the name of Hosseinis. The Syrian Ismaelites live in the district of Massiat or Massvad. Their Castle was taken from them in 1809 by the Nossaries, but afterwards restored.

ASSAULT.—Assaults are of two kinds; open assaults and those made with great secrecy. Whatever be the kind of assatilt, it should be preceded by reconnoissances, made as full as possible, for the purpose of ascertaining the best and easiest approaches to the work, the nature and position of the obstacles, the numbers and kinds of troops composing the garrison, and the strength and positions of the reserves exterior to the work, but near enough to take part in its defense. Particular attention should also be paid to the positions for the artillery of the attack. These positions should be such that the guns can bring enfilading fires on the principal faces of the work, strong cross fires upon the point of attack, and if possible a sweeping fire on the approaches to the work in rear. An important point to be observed in this matter is to select, if possible, positions from which the guns will not have to be removed during the attack.

In any assault, it is necessary that the Officer Commanding and responsible for the whole operation should be in immediate communication with the troops during the assault, and be present with the reserve or supporting party. The troops destined for this duty should be divided into two portions, *each* equal in strength to three fourths of the garrison attacked: one portion being the attacking party, and the osher half the reserve or supporting party. Each column of the attacking party will also be subdivided into advance, main body, and support, whatever may be the number of these columns. The disposition of the attacking party, as it reaches the point of attack, will be regulated by the Engineer Officer, under the orders of the Officer Commanding—they having made the necessary reconnoissances; the party must be furnished with tools, ladders, and proper implements, adapted to the circumstances of the moment, and accompanied by a detachment of sappers. The disposition of the reserve, equal, as before observed, to the whole attacking force, should be regulated by the officer intrusted with the execution of the assault; and this reserve should be accompanied or not, according to circumstances, by cavalry and field-artillery. When these descriptions of force are present, the former should be placed under cover or out of gun-shot, about 1500 yards distant; the artillery should be kept in hand until the attacking party is engaged, when the guns should be spread out on the flanks and open a vigorous fire upon the works; the infantry, brought immediately in rear of the leading attack, should be placed under cover, if possible, from fire of grape and musketry, and halted until the issue of the first assault is seen. It is impossible to regulate an assault by any minute suggestions for the advance, except to observe that it is usual for each column to attack the salient points of the works and least defended portions; to throw out skirmishers and firing-parties under any cover available, and keep up a rapid and compact fire upon the defenders; to follow with the sappers and grenadiers to force all obstructions; and then to advance the main body, the supports of each column being judiciously planted in the rear. Eventually, as success occurs and the whole move on, points of security should be taken up, such as the reverse, or the exterior slope of the works; buildings, walls, as well as gorges and flanks, which frequently give cover. Men should be planted under an officer, with instructions to take no notice of the pell-mell, but to keep up a heavy firing in front; employing the sappers in intrenching the position taken up by the supporting party, or in collecting wagons, carts, carriages, etc., capable of being made into a barricade. Either on the supposition that the success of the assault is doubtful, or that there is a check or repulse, the reserve, in case of doubtful success, to render the attack doubly sure, should move forward under the Officer Commanding the whole assaulting force, and relieve the assailants, who take their places as the reserve as soon as order can be restored; the artillery brought into position in the openings, between the advancing columns, would be directed upon the retreating or resisting forces; and if success is finally complete, the cavalry, in the event of their being employed, will move forward, either through the openings cleared, or by a detour, if a fortified town, in pursuit.

In the second case—that of a check—the reserve, on the reconnoissance of the Officer Commanding, will either march forward in support of the attack, or to cover the retreat, if further perseverance in the assault is deemed impracticable—the artillery and cavalry being warned as to the intention. In the event of the assault being repulsed, the reserve, which should be in echelon, having advanced-guards in front, will allow the retreating party to move through the intervals, and the advanced-guard will endeavor to check the pursuit; if overpowered, they will fall back on the reserve, and the whole may in that manner retreat until beyond gun-shot, endeavoring to make a stand, repulse the garrison, and if possible convert failure into success, if the pursuit has been badly conducted and without due caution. As an important rule in all assaults, except in partial attacks, as an outwork, or any particular work in which a lodgment is to be made, the composition of the forces should be by regiments and corps, and not by detachments; and each non-commissioned officer should be provided with the means of spiking a gun, for which purpose even an old nail is sufficient. *Assaults*, if *feasible*, would seldom fail with these precautions, and there are few posts not open to assault, by taking the proper opportunity. An officer intrusted with the defense of a place should therefore exercise the most unremitting vigilance. See *Attack*.

ASSAY FURNACE.—A furnace with a chamber or muffle in which the metallic ore or alloy to be tested is exposed to heat. Assaying is more generally followed in the examination of compounds of silver and gold, but is likewise resorted to in the investigation of ores of iron, copper, tin, zinc, bismuth, antimony, mercury, and lead. In manufactured articles, also, some foreign metal (generally copper) is present, to impart hardness to the metal; and in Great Britain each article is assayed at the Goldsmiths' Hall, previously to being sold, so as to determine the exact richness of the metal whereof it is made. In the assay of compounds containing silver, the apparatus employed is a *cupel*, a small basin-shaped vessel made of bone-ash; and a *muffle*, composed of fire-clay, about eight inches in length and three to four inches in diameter, shaped like a miniature railway-tunnel, open at one end, closed at the other end, and having numerous slits or air-holes along the side. The drawing shows the Judson Assay Furnace, much used in Ordnance Laboratories. It is constructed in three sections, whereby the following advantages are secured: the risk of cracking, by unequal expansion and contraction, is much diminished; without sacrificing anything in strength, the gross weight is considerably reduced; and the furnace is rendered very portable. The grate is a revolving one. The convenience of this in removing ashes and clinkers is too evident to need comment. The muffle-doors and the door for feeding and crucible operations are large. There is a muffle-door in both front and back in order to use a muffle open at both ends. The advantages of this style of muffle are the greater convenience in working the charge, the diminished risk of cracking by unequal expansion and contraction, and the better



circulation of air over the contents. The ordinary muffle, closed at the back, can also be used as with any other furnace. The doors have small holes in them through which the reactions going on within the muffle may be watched without injury either to the operation or the operator.

ASSEGAI.—A light projectile spear employed by the Kaffirs. Also written *Assagai.*

ASSEGUAY.—A kind of knife-dagger, used very commonly in the Levant.

ASSEMBLING.—The act of putting in their respective places and fastening together the component parts of an article composed of a number of distinct pieces, so as to form a complete and perfect whole; as the cheeks and stock of a gun-carriage, with their connected parts; the lock, stock, and barrel of a musket, etc. The term is more peculiarly applicable to the fitting together of parts which are made strictly to fixed shapes and dimensions so as to be promiscuously interchangeable. The system of interchangeability of parts was first introduced into the French Artillery service by General Gribeauval, about the year 1765. This system was further simplified and extended, and was finally applied in the United States Arsenals and Armories to all articles made up of pieces, the improvements in machinery enabling most articles to be made accurately to pattern without depending on the eye and hand of the workman. This has been carried to a very high pitch of improvement by means of the machinery at the Springfield Armory and other manufactories of small-arms in this country; and the beauty and utility of the system, by which exact equality of dimensions is insured in every one among thousands of almost microscopic screws and other small parts, are particularly exemplified in the work of the American watch and sewing-machine companies. This system of interchangeability and assemblage, which by enabling a large proportion of perfect and serviceable articles to be made up from the parts of similar articles which have been broken or injured in use, instead of permitting them to be cast into the scrap-heap, is one of the most beautiful triumphs of modern mechanism. It has proved itself capable of adaptation to large as well as small machinery, and is now applied to the locomotives of the Pennsylvania Railroad.

ASSEMBLING-BOLT.—A bolt used for holding together two or more removable pieces, as the cheeks and stock of a field gun-carriage.

ASSEMBLY.—In the conduct of an army, the second beating of the drum or sounding of the bugle before a march, at which the soldiers strike their tents if encamped, roll them up, and stand to arms.

ASSER.—An instrument of warfare used by the Romans on their war-ships; it consisted of a heavy pole with an iron head, and was used as a battering-ram against hostile ships. Other authorities assert that it was used to destroy the rigging only.

ASSESSMENT OF DAMAGES.—In the English army, the determination by a Committee of Officers of the value of the injury done to the barracks each month, in order that stoppages in liquidation may be made from men who have committed the damage.

ASSIDUI MILITES.—Roman soldiers who, for the love of arms, served in the army without receiving pay or emoluments.

ASSIGNMENT OF PAY.—The assignment of pay by a non-commissioned officer or private previous to discharge is invalid. A transfer subsequent to discharge is valid.

ASSINAIRES — ASSINARIES. — Festivals which were instituted at Syracuse in commemoration of the destruction of the Athenian fleet commanded by Nicias and Demosthenes.

ASSISTANT. — In the English army, the third grade in any particular branch of the Staff, such as the Quartermaster-General's or Adjutant-General's. After the Principal comes the Deputy and then the Assistant. In the United States it is the second grade in the Staff of the Army.

ASSISTANT ADJUTANT-GENERAL.—In the English army, a Field-Officer and a subordinate member of the Adjutant-General's Department. An officer of this rank is attached to each division of the army. His duties include the submission of reports on discipline, military duties, training, and efficiency, to the General Officer Commanding the Division. Through his Department the bulk of the correspondence on arms, accouterments, ammunition, etc., passes before being sent on to the Control Department. The Adjutant-General of the United States army has similar Assistants.

ASSISTANT SURGEONS.—All candidates for appointment as Assistant Surgeons must apply to the Hon. Secretary of War for an invitation to appear before the Medical Examining Board. The application must be in the handwriting of the Candidate, stating age and birthplace, and be accompanied by testimonials from Professors of the College in which he graduated, or from other Physicians in good repute. Candidates must be between twenty-one and twenty-eight years of age (without any exceptions), and graduates of a regular Medical College, evidence of which must be submitted to the Board before examination. The morals, habits, physical and mental qualifications, and general aptitude for the service of each Candidate are subjects for careful examination by the Board, and a favorable report is not made in any case in which there is a reasonable doubt.

The following is the general plan of the examination: 1. A short essay, either autobiographical or upon some professional subject—to be indicated by the Board. 2. Physical examination. This will be rigid, and each Candidate will, in addition, be required to certify "*that he labors under no mental or physical infirmity, nor disability of any kind, which can in any way interfere with the most efficient discharge of his duties in any climate.*" 3. Oral examinations on subjects of preliminary education, general literature, and general science. The Candidate must satisfy the Board in this examination that he possesses a thorough knowledge of the branches taught in the Primary Schools, and a failure to show this will end his examination. Oral examination on scientific subjects will include chemistry and natural philosophy; and that on literary subjects will include English literature, history of the United States, and general history—ancient and modern. Candidates possessing a knowledge of the higher mathematics, the ancient and modern languages, will be examined therein, and due credit given for a proficiency in any or all of these subjects. 4. Written examination on anatomy, physiology, surgery, practice of medicine and general pathology, obstetrics, and diseases of women and children. Oral examination on these subjects, and also on medical jurisprudence, materia medica, therapeutics, pharmacy, toxicology, and hygiene. Few Candidates pay the attention to hygiene which it deserves; it is made an important subject in this examination. 5. Clinical examination, medical and surgical, at a hospital. 6. Performance of surgical operations on the cadaver. The Board deviate from this general plan whenever necessary, in such manner as they deem best to secure the interests of the service. An applicant failing one examination may be allowed a second after one year, but not a third. No allowance is made for the expenses of persons undergoing examination. See *Medical Department.*

ASSIZE OF ARMS.—A law enacted in the reign of Henry II. which enjoined every able-bodied man in the realm to maintain arms, suitable to his rank and condition of life, at his own expense. Of this law our militia is the modern offspring, and there can be no doubt that it is incumbent on every British subject now, as it was in earlier times, to give his service when required in defense of his Sovereign and Country. The enforcement therefore of the ballot in the militia would be no hardship.

ASSOCIATION OF GRADUATES OF THE MILITARY ACADEMY.—An Association of all Graduates of West Point who comply with the provisions of its Constitution. The Association was organized in 1869. Its object is "to cherish the memories of our Alma Mater and to promote the social intercourse and fraternal fellowship of its Graduates." The meetings of the Association are held annually at West Point, about the time that the graduating exercises take place. The oldest Graduate belonging to the Association is its President. The other officers are appointed annually by the President. At the present time (April, 1884) the Association has 531 members on its rolls. The oldest living Graduate is John T. Pratt, of the class of 1818, living at Georgetown, Ky. The Association endeavors to keep a record of all Graduates of the Academy. After the annual meeting in June, a report is published by the Secretary containing obituary notices of deceased Graduates, together with other matters of interest relating to the Military Academy.

ASTIGMATISM.—An anomaly in the refraction of the eye which, by law, disqualifies a recruit for enlistment in the army. Although this defect is very common, yet not until the last few years were its fre-

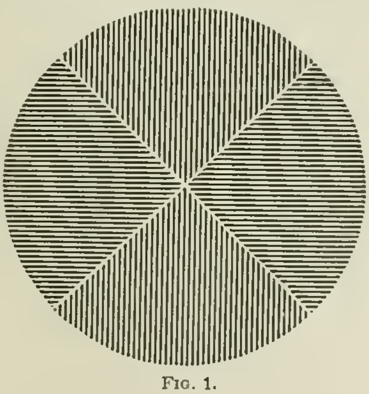


Fig. 1.

quency and importance fully recognized. Astigmatism is a condition in which the curvature of the cornea varies in the different meridians (Fig. 1). On examining an ordinary lens we find that all parts of its surface have an equal curvature (Fig. 2), and so it should be in a normal cornea; but in an astigmatic eye it is not so, since the vertical curvature differs from the horizontal, thus producing asymmetry of the refractive part of the eye, and, as a result, rays falling on such an eye are not all brought to a single focus, but those in one meridian fall either before or behind the retina, or focal point of the other meridian,

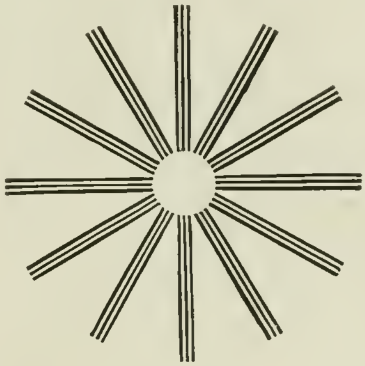


Fig. 2.

thus causing a confused and indistinct picture of the object viewed. Astigmatism is either Myopic or Hypermetropic; it may also be "mixed"—the eye being Myopic in one and Hypermetropic in another of its meridians.

Vision in astigmatic eyes is usually impaired both for distant and near objects, since at no point can a

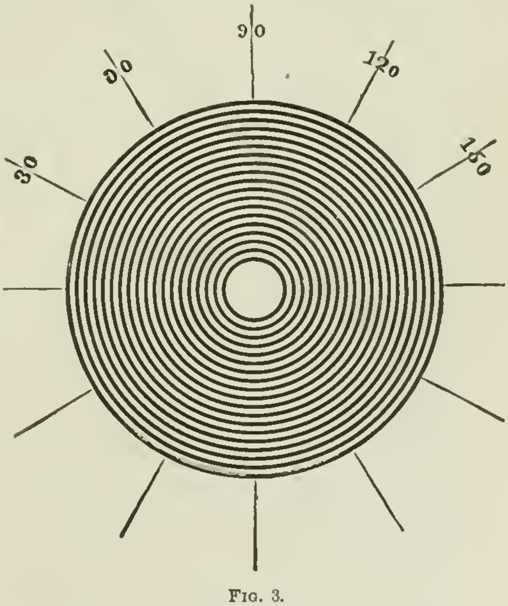


Fig. 3.

distinct image be obtained; but the distinguishing feature of this defect is the fact that certain groups in a series of lines and circles are seen with more distinctness and blackness than any others. (Fig. 3.) Astigmatism has frequently been discovered by looking at a clock, it being noticed that when the hands were at certain figures, say III and IX, they were seen with difficulty, while when at VI or XII they were distinctly seen.

In the treatment of Astigmatism, recourse must be had to *cylindrical lenses,* as the ordinary lenses would not correct the defect. Since the correcting glasses for Astigmatic eyes are frequently combinations, these lenses are always ground according to formula to correct the defect of each individual eye, which can only be determined after careful measurement. See *Recruits*.

ASTRAGAL.—A small convex molding used in the ornamental work of ordnance, and usually connected with a flat molding or *fillet*.

ASTROLABE.—The name given by the Greeks to any circular instrument for observing the stars. Circular rings, arranged as in the armillary sphere, were used for this purpose. A projection of the sphere upon a plane, with a graduated rim and sights for taking altitudes, was known as an astrolabe in the palmy days of astrology, and was the badge of the astrologer. The astrolabe has been superseded by the more perfect instruments of modern astronomy.

ASTYLLEN.—A small dam in an adit or mine to prevent the full passage of the water.

ASYLUM.—The persons entitled to the benefits of the Asylum, or Soldier's Home as it is now called, located in the District of Columbia, are: 1. All soldiers, and discharged soldiers of the army of the United States, who may have served honestly and faithfully for twenty years. 2. All soldiers, and discharged soldiers of the Regular Army, and of the Volunteers, who served in the war with Mexico, and were disabled by disease or wounds contracted in that service and in the line of their duty, and who are, by their disability, incapable of further military service. This class includes the portion of the Marine Corps that served with the army in Mexico. 3. Every soldier, and discharged soldier, who may have contributed to the funds of the Soldier's Home since the passage of the Act to found the same, March 3, 1851, according to the restrictions and provisions thereof, and who may have been disabled by disease or wounds incurred in the service and in the line of his duty, rendering him incapable of military service. 4. Every pensioner on account of wounds or disability incurred in the military service—though not a contributor to the funds of the Institution—who shall transfer his pension to the Soldier's Home during the period he voluntarily continues to receive its benefits. No provision is made for the wives and children of those admitted.

No mutineer, deserter, or habitual drunkard, or person convicted of felony or other disgraceful crime of a civil nature, while in the army or after his discharge, is admitted into the Asylum without satisfactory evidence being shown to the Commissioners of the Soldier's Home of subsequent service, good conduct, and reformation of character. The Commissioners are the Adjutant-General, the Commissary-General of Subsistence, and the Surgeon-General. The Soldier's Home has its Governor, Secretary, and Treasurer appointed from the army. See *Royal Military Asylum*.

AS YOU WERE.—A word of command corresponding to the French *remettez vous*, frequently used by drill-masters to cause a resumption of the previous position when any motion of the musket or movement of the body has been improperly made.

ATCHEVEMENT.—A term nearly equivalent to armorial bearings, and often used when speaking of the arms of a deceased person as displayed at his funeral or elsewhere. In this sense it is more commonly used in its abbreviated form of *hatchment*.

ATEGAR.—The old English hand-dart, named from the Saxon *aeton*, "to fling," and *gar*, "a weapon."

ATHANATI.—A corps of picked soldiers belonging to the ancient Persian army, 10,000 strong, which were called the "Immortals," for the reason that as soon as one of the corps died another was put in his place.

ATHLETE.—The name given to a combatant, pugilist, wrestler, or runner, in ancient Greece. Athletics were studied in Greece as a branch of art, and led to several useful rules of diet, exercise, etc., applicable to ordinary modes of life. Bodily strength and activity were so highly honored by the Greeks that the athlete held a position in society totally different from that of the modern pugilist. When he proposed to enter the lists at the Olympic or other public games, he was examined with regard to his birth, social position, and moral character. A Herald then stepped forth and called upon any one, if he knew aught disgraceful to the Candidate, to state it. Even men of genius contended for the palm in athletic exercises. Chrysippus and Cleanthes, the famous philosophers, were victorious athletes, or, at least, *agonista*, i.e., persons who pursued gymnastic exercises, not as a profession, but for the sake of exercise, just as at the present day we have gentlemen-cricketers, amateur-pugilists, etc. The profound and eloquent Plato appeared among the wrestlers in the Isthmian games at Corinth, and also in the Pythian games at Sicyon. Even the meditative Pythagoras is said to have gained a prize at Elis, and gave instructions for athletic training to Eurymenes, who afterwards gained a prize at the same place. So great was the honor of an Olympian victor that his native city was regarded as ennobled by his success, and he himself considered sacred. He entered the city through a special breach made in the walls; he was supported at the public expense; and when he died was honored with a public funeral. Euthymus, of Locri in Italy, who had, with only one exception, been regularly victorious at Elis, was honored with a statue, to which, even during his lifetime, homage was paid by command of an oracle. Athletic sports were first witnessed at Rome 186 B.C. They were introduced by M. Fulvius, at the end of the Ætolian War, and became excessively popular in the time of the Emperors. At Rome the athletes formed a corporation.

ATILT.—In the manner of a tilter; in the position or with the action of a man making a thrust. "To run atilt at men."

ATLAS METAL.—The metal used in the manufacture of the cases of Hale's rockets and Boxer's life-saving rockets. It is a mild steel produced by the Bessemer process.

ATLAS POWDER.—A nitro-glycerine compound of great explosive power, uniting that element in a marked degree with safety. When not confined it burns quite harmlessly; but when fired by a blasting-cap it explodes with enormous force. In cold weather it hardens and freezes, but resumes its soft, pasty condition when warmed. To secure its full explosive power it must never be used even in a semi-frozen state. As the tendency of all nitro-glycerine compounds is to decompose when exposed for any length of time to the direct rays of the sun, whatever the temperature of the air may be, great care should be taken not to expose this powder, or any other compound of a similar nature, to a test of that kind.

As an industrial agent this powder is stronger, cheaper, and safer than most other blasting-compounds. No invariable rule can be laid down as to the diameter and length of cartridges to be used under any and all circumstances, nor the amount nor grade of powder required for all kinds of work. Much will have to depend upon the good sense and judgment of the persons using the powder. As a general rule it throws rock less and breaks it more, and extends its effects much deeper than ordinary blasting powder; and those who use it soon learn not to judge of a blast by first appearances. It frequently happens that a blast which seems to have had no effect proves to have done remarkable execution in cracking and loosening the rock, and preparing the way for subsequent blasts. This is especially the case in tunnels and shafts.

The powder is put up in cartridges of either 6 or 8 inches in length, and from ¾ inch to 2 inches in diameter, is packed in 25-lb. and 50-lb. boxes, and is branded as follows:

F+,	Powder	containing	15	p.	c.	of Nitro-Glycerine.
E,	"	"	20	"	"	"
E+,	"	"	25	"	"	"
D,	"	"	30	"	"	"
D+,	"	"	35	"	"	"

C,	Powder containing	40 p. c.	of Nitro-Glycerine.
C+,	"	45 "	"
B,	"	50 "	"
B+,	"	60 "	"
A,	"	75 "	"

See *High Explosives*.

ATMIDOMETER. — An instrument used in the English Medical Corps for measuring the rate of evaporation. Also written *Admometer*.

ATMOSPHERIC HAMMER. — A power-hammer driven by the force of compressed air. In some cases the air is employed merely to lift the hammer; in other cases air is also employed as an adjunct in the effective stroke. In the latter case the operation is much like that of the steam-hammer, the main difference being in the substitution of air for steam.

ATTACH.—To place or appoint. Officers and Non-commissioned Officers are said to be attached to the respective army, regiment, battalion, troop, or company with which they are appointed to act.

ATTACHE.—The seal and signature of the Colonel-General in the old French service, which were affixed to commissions of officers after they had been duly examined.

ATTACK.—An advance upon the enemy, with a view of driving him from his position. It may either be an attack in the open field or an attack upon a fortress. In an attack in the open field, the General first ascertains the strength and position of the enemy, by means of a reconnoissance or of spies. He then seeks to discover at what point the enemy can make the least resistance; which is generally on one or other flank. He next arranges to concentrate his chief strength upon this particular point, and to mask his real intention by feigned operations in other places. He then attacks with energy and force, his troops advancing without halt till near enough to use their weapons with the greatest effect. The more the attack has the character of a "surprise," the greater the probability of its success. In order to make this success as much felt as possible, and to be provided also against unforeseen disaster, the attacking body should be followed at a distance by a reserve; a neglect of this precaution has frequently caused the entire failure of an attack. Various forms have been devised for the attack; but generally the *parallel* or *frontal* is the one made use of. Frederick the Great, however, won most of his battles by the oblique attack, in which one wing is more advanced than the other. The first Napoleon preferred, by means of his heavy columns, to penetrate and break up the enemy's center. Another mode combines an attack on one flank as well as in front, by two separate corps, so as either to get into the enemy's rear, or to perplex him as to his retreat. A skillful General will be guided by circumstances in his selection among these several modes of operating. An attack by night might act most signally as a surprise; but as this requires a very exact knowledge of the ground, an attack at early dawn is generally preferred.

The different arms of the service render each its own kind of aid during an attack. First come the skirmishers, or perhaps whole battalions of light and active troops, whose rifles or long-range guns commence the firing. Then come the main body of infantry in heavy column; they halt within musket-shot, fire, and charge with the bayonet—the skirmishers meanwhile deploying round to the rear of the column, but holding themselves in readiness to harass the enemy's flanks. English troops especially excel in the attack by bayonet in line; but other armies, for the most part, rely more upon the momentum of a compact and heavy column in an attack. There are positions in which the cavalry attack, with its shock and the use of the sword, is more efficacious than that of the infantry. The troopers approach at a trot, break into a gallop at a distance of one or two hundred paces from the enemy, and endeavor by their weight and impetuosity to force the enemy's line. There are many forms of cavalry attack, according to the nature of the ground and the position of the enemy. The artillery, working at a distance, often begin an attack long before the infantry and cavalry can come up, harassing and confusing the enemy. At 800 to 1200 yards' distance, the artillery pour out shot and shell, and try to silence the enemy's guns, so as to make way for the attack of the infantry; while the bayonet-charge is being made, the artillery keep in check the enemy's cavalry. If the attack succeeds, the infantry and artillery take up the ground recently occupied by the enemy, leaving the cavalry and riflemen to maintain a pursuit; but if it fail, the artillery and cavalry take up such positions as will cover the retreat of the infantry.

In an attack upon a fortress, the operation is a part of that of besieging; but very often intrenchments are attacked in the open field. Such an attack has the character of a surprise, when the works are approached under cover of night, and an attempt is made to break into them on all sides. In such case, there is a reserve corps, which is rapidly brought up when wanted; but the attacking corps retire behind the reserve, if repulsed. The artillery post themselves on the prolongation of the line of works, and try to dislodge the enemy's guns and gunners; or pour a concentric fire sufficient to breach the works. The infantry advance as close as will enable them to fire upon the gunners. When the enemy's fire is silenced, the engineers (under cover of the artillery) proceed to remove palisades and all other obstacles, and to bridge over ditches and openings. Then follow the operations of the storming-party, analogous to those noticed under *Assault*.

ATTACK OF TEMPORARY FORTIFICATIONS.—The subject of the attack admits of two natural divisions; the first of which comprehends all the preliminary steps taken before the troops are brought into action; the second, all the subsequent operations of the troops. An attack is made either by *surprise* or *openly*. In both cases exact information should be obtained of the approaches to the works; their strength; the number and character of the garrison; and also the character of the Commander. This information may be obtained through spies, deserters, prisoners, and others who have access to the works; but implicit faith ought not to be placed in the relations of such persons, as they may be in the interests of the garrison; and in all cases they should be strictly cross-examined and their different representations be carefully compared with each other. The best source of information is an examination, or *reconnoissance*, made by one or more intelligent officers. This reconnoissance should, if possible, be made secretly; but as this will not be practicable if the garrison show even ordinary vigilance, it will be necessary to protect the reconnoitering officer by small detachments, who drive in the outposts of the garrison. The object to be attained by the reconnoissance is an accurate knowledge of the natural features of the ground exterior to the works; the obstacles it presents, and the shelters it affords to troops advancing; the obstacles in front of the counterscarp and in the ditches; the weak and strong points of the works, and the interior arrangements for the defense. If the work is an isolated post, information should be obtained as to the probability of its being succored in case of an attack; the length of time it must hold out to receive succor; and the means it possesses of holding out.

A surprise is an *unexpected attack*, for which the assailed are not prepared. It is, perhaps, the best method of assailing an undisciplined and careless garrison, for its suddenness will disconcert and cause irremediable confusion. Secrecy is the soul of an enterprise of this nature. To insure it, the garrison, if aware of the presence of the troops, should be deceived and lulled into security by false maneuvers. The troops that form the expedition should be kept in profound ignorance of its object until they are all assembled at the point from which they are to proceed to the attack. The winter season is the most favorable for a surprise, which should be made about two hours before day, as this is the moment when the sentries are generally least vigilant, and the garrison is in profound sleep; and the attempt, if at first successful, will be facilitated by the approach of day, and if unsuccessful, the troops can withdraw with safety under the obscurity of night. Should there be danger, from succors arriving in a short time, the attack should be made soon after midnight, when the garrison is asleep, so that the troops may retire before daylight, after having attained their object. As a general rule, the troops for the attack should consist of a storming party, divided into an advanced party and its support, and be followed by a reserve of picked men. The advance of the storming party will open the way, and be closely followed by the support in the assault of the parapet, and a reserve of picked men. There should be two guides, one in front of the storming party, with the detachment of workmen under the command of an engineer officer; the other in the rear, under charge of a guard, to supply the place of the first, if killed. The workmen should be furnished with axes, crowbars, pickaxes, etc., and several bags of powder, of about thirty pounds each, to be attached to palisadings, fraises, and barriers, to blow them down, if the alarm should be given whilst they are opening a way through them by other means. All the operations should be carried on with dispatch and in silence. Should the sentries challenge, they must be secured or bayoneted. Circumstances alone can determine whether it will be advisable to make false attacks with the true one. They will distract the attention of the garrison, if the alarm is given, from the true attack; and a false attack has sometimes succeeded when the true one has failed. When made, one should be directed against the strongest point of the work, as the strong points are usually guarded with less vigilance than the others; and they should all be made at some distance from the true attack; and orders be given to the detachments making them to proceed to the point of the true attack, should they succeed in making their way into the work. If the attack succeed, immediate measures should be taken to place the works in a state of defense, if the position is to be maintained; or else they should be destroyed, as far as practicable, before retreating from them.

The general arrangements for an open assault comprehend the operations to gain possession of the works; the measures for maintaining possession of them, and following up the first advantage; and, finally, the precautions to be observed in the event of a repulse. An open assault may be made either with the bayonet alone, or with the combined action of artillery and the bayonet. The first is the most expeditious method, but it is attended with great destruction of life; it should therefore only be resorted to against works of a weak character, which are feebly guarded; or against isolated posts within reach of speedy succor. When tried it will usually be best to make the attack just before day. If it is made by daylight it will, in most cases, be well to scour the environs with a few squadrons of cavalry, to pick up patrols and stragglers who might give the alarm, and then push forward rapidly the assaulting columns. If the assailed seem prepared, light troops should precede the columns of attack, with orders to display in front of the counterscarp and open a brisk fire on the assailed, for the purpose of diverting their attention from the columns of attack. In an attack with artillery, the troops are drawn up in a sheltered position, or beyond the range of the guns of the assailed; batteries are then established within twelve to six hundred yards of the works, in the most favorable positions to enfilade the faces, and destroy all visible obstacles. The batteries keep up an incessant fire of ball and hollow projectiles, in order to dismount the cannon and create confusion among the assailed. When the fire of the works is silenced, the troops are thrown forward, and demonstrations are made on several points, to divert the attention of the assailed from the true point of attack, and prevent him from concentrating his strength on that point. Several false attacks should be made at the same moment with the real one, and each of them should be sufficiently formidable, in point of numbers, to enable the troops to profit by any success they may obtain. The number and disposition of the troops making the assault will depend, in so great a degree, on local circumstances, and the arrangements of the assailed, that nothing more can be laid down under this head than some general rules. The attack should be led by a storming party, composed of picked troops, or of volunteers for the occasion; this party is preceded by a detachment of engineer troops, provided with the necessary means to make their way through all obstacles, to enable the storming party to assault with the bayonet. If the detachment is arrested at the crest of the counterscarp, by obstacles which must be destroyed before further progress can be made, the leading files of the storming party may open a fire on the assailed to divert their fire from the workmen; but this operation should only be resorted to from necessity, as it breaks in on that unity so essential in an operation of this character, and impairs the confidence of the soldier in the bayonet, on which his sole reliance, in such cases, should be placed. The storming party should be provided with light scaling-ladders, planks, fascines, strong hurdles, etc., for the purpose of descending into the ditch; to mount the scarp; to cover trous-de-loup, small pickets, etc., etc. Another detachment of engineer troops follows in the rear of the storming party; its duties consist in rendering the passages, opened by the first detachment, more accessible to the troops, who immediately follow it to sustain the storming party. This second detachment is also charged with the care of placing the work from which the assailed has been driven in a defensive attitude, in order to frustrate his attempt to repossess himself of it. The first detachment should be charged with this duty; for, independently of having handsomely acquitted itself in bearing the brunt of the action, it may be required to precede the storming party in the pursuit of the assailed to his interior works. The troops destined to support and, if necessary, reinforce the storming party, advance in one or two lines, with cavalry, and some pieces of artillery on the wings, to repel sorties. The remainder of the troops follow in order of battle, to improve the first successes, or to cover the retreat of the assaulting columns, if repulsed.

The salients are generally the points on which the storming party advances, unless some natural feature of the ground should present greater facilities for advancing on a re-entering, or in front of a face. When the ditch is gained, shelter is sought in a dead angle; and if the work is fraised, or resolutely defended with the bayonet, a breach must be made, either by firing beforehand hollow loaded projectiles into the parapet, or by undermining the scarp with the pick. If the intrenchments consist of detached lunettes, an attack should be made on their gorge at the same moment with the one in front. When the assailed are driven from their main works, the storming party should press hotly on their rear, and endeavor to enter pell-mell with them into their interior works, leaving to the troops which follow them the care of retaining possession of the works gained; but if the intrenchments are supported by other troops drawn up in order of battle, the storming party should halt in the works until it is reinforced by the troops in its rear. There is no danger to be apprehended, in case of a retreat, after an unsuccessful attack on an isolated work. But in an attack on intrenchments, supported by an army, the retreat of the storming party should be covered by cavalry and artillery until it can find safety behind the main body of the troops drawn up in order of battle to protect it, and to receive the assault of the assailed should he attempt offensive operations. In conducting the attack, preparations should be made beforehand for removing all the artificial obstacles that the assailed may have placed before their works to impede the progress of the storming party. This duty is usually intrusted to the detachment of engineer troops, who are provided with axes, picks, and other suitable tools for this purpose. When the obstacles are of a nature to be easily destroyed by artillery, it should always be resorted to. Abattis, palisades, fraises, and entanglements, when exposed, may be readily torn to pieces by opening an enfilading ricochet fire on them. When cannon cannot be brought to bear on these obstacles, an abattis may sometimes be set fire to, and palisades, etc., be blown in by attaching bags of powder to them. Trous-de-loup may be passed, either by covering them with plank or strong hurdles, or else by directing the men to pass cautiously between them in extended order; small pickets may be broken down, or else fascines may be spread over them so as to form a tolerably stable roadway; fascines may also be used to cover the points of spikes.

The passage of the ditch and the assault of the parapet are the most difficult operations. If the ditch is not more than six feet deep, it can be leaped into without danger, and the men can mount the scarp readily with a very little assistance from each other. When the width is not greater than twelve feet, the ditch may be crossed by laying thick plank or small scantling over it. When the depth is over six feet, the storming party is usually provided either with small scaling-ladders for descending into, or with fascines, sand-bags, or other means to fill the ditch partly up; or if these means cannot be procured, the detachment dig away the counterscarp into steps, throwing the earth into the ditch, and thus in a short time form an easy entrance to it. Wet ditches may be filled up either with sand-bags alone, or more expeditiously by attaching sand-bags to large fascines or to trusses of hay or straw. The assault of the parapet is made by the aid of scaling-ladders, or by effecting a breach by firing loaded hollow projectiles into the scarp and parapet, which by their explosion crumble the earth down so as to form an accessible ramp; or else the foot of the scarp is undermined with the pick, and the mass of the parapet tumbled into the ditch. See *Assault* and *Defense*.

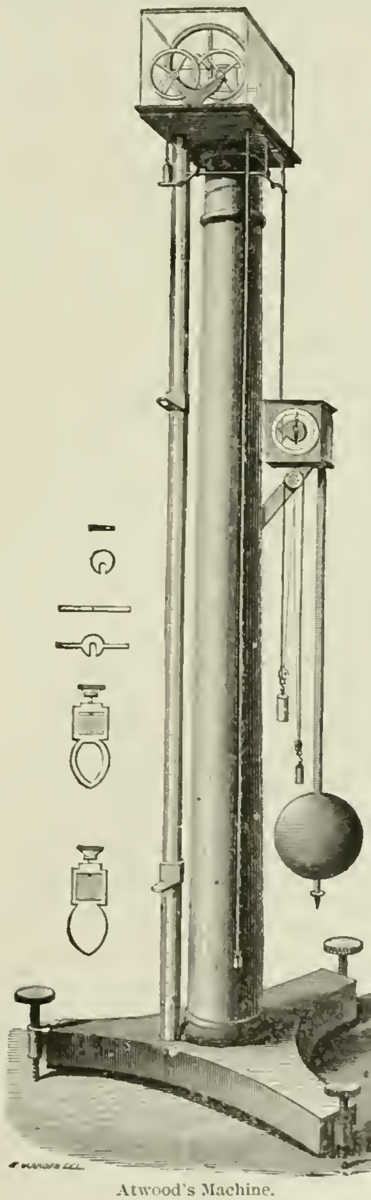
ATTENTION.—A cautionary command addressed to troops preparatory to a particular exercise or maneuver. *Gare-a-vous* has the same signification in the French service.

ATTESTATION.—In the English service, a certificate which is granted by a Justice of the Peace within four days after the enlistment of a recruit. This certificate bears testimony that the recruit has been brought before the Justice in conformity to the Mutiny Act, and has declared his assent or dissent to such enlistment, and that (if according to the said Act he shall have been duly enlisted) the proper oaths have been administered to him by the Magistrate, and the sections of the Articles of War against mutiny and desertion read to the said recruit.

ATTICK BRONZE REINFORCE.—The exact material of this *hoop* reinforce was never made public, inasmuch as it was supposed to have a great tensile strength. This method of reinforce was tested on the Naugatuck. An old cast-iron 42-pdr. had a hoop of this *Bronze Composition* forced on by hydrostatic pressure. The gun was first tried with 100-lb. projectiles (James') and 16-lb. charges. The endurance for a while appeared satisfactory, but the gun subsequently burst after a short service.

ATWATER GUN.—A 5.85-inch (80-pdr.) hooped gun, experimented with at the Washington Navy Yard. It is a cast-iron gun, 21 inches in diameter at the breech, with a tier of six wrought-iron hoops, 6×2 inches each, shrunk on, and a second tier of five similar hoops over the first tier. Length of bore, 12 feet; weight, 11,625 pounds. This gun is remarkable in its rifling. It has 12 grooves $\frac{1}{10}$ inch deep, and 12 lands of equal width at the breech. At 12 calibers from the bottom of the chamber the lands are cut away in alternate pairs to $\frac{1}{4}$ inch below the bottom of the original grooves. Other conditions remaining the same, the range of projectiles from this bore is considerably increased. This result is ascribed to various causes. Decrease of friction would be better promoted by cutting off the chase altogether. The more perfect combustion of the powder by the air entering at the side of the shot would also follow, leaving an air-space in the chamber of the gun; in fact, to the sudden and perfect combustion thus promoted some authorities attribute the bursting of guns. The inventor reasons from the experiments of Rodman that the air-pressure in front of the shot is greater than the gas-pressure behind it, at the point where he cuts the lands away.

ATWOOD'S MACHINE.—An instrument for illustrating the relations of time, space, and velocity in the



Atwood's Machine.

motion of a body falling under the action of gravity. It was invented by George Atwood (or Attwood), a mathematician of some eminence, who was born in

1745, educated at Cambridge, became Fellow and Tutor of Trinity College in that university, published a few treatises on mechanics and engineering, and died in 1807. It is found that a body falling freely passes through 16 feet in the first second, 64 feet in the first two seconds, 144 feet in the first three seconds, and so on. Now, as these spaces are so large, we should require a machine of impracticable size to illustrate the relations just mentioned. The object of Atwood's Machine is to reduce the scale on which gravity acts without in any way altering its essential features as an accelerating force. The machine consists essentially of a pulley, moving on its axis with very little friction, with a fine silk cord passing over it, sustaining two equal cylindrical weights at its extremities. The pulley rests on a square wooden pillar, graduated on one side in feet and inches, which can be placed in a vertical position by the leveling-screws of the sole on which it stands. A pendulum usually accompanies the machine, to beat seconds of time. The weight of the cylinders being equal, they have no tendency to rise or fall, but are reduced, as it were, to masses without weight. When a weight is placed on one of the cylinders, the motion that ensues is due only to the action of gravity upon it, so that the motion of the whole must be considerably slower than that of the weight falling freely. Suppose, for instance, that the cylinders are each $7\frac{1}{2}$ ozs. in weight, and that the weight is 1 oz.: the force acting on the system—leaving the friction and inertia of the pulley out of account—would be $\frac{1}{16}$ of gravity, or the whole would move only 1 foot in the first second, instead of 16. If the weight be left free to fall, its weight or moving force would bring its own mass through 16 feet the first second; but when placed on the cylinder, this force is exerted not only on the mass of the bar, but on that of both cylinders, which is 15 times greater, so that it has altogether 16 times more matter in the second case to move than in the first, and must, in consequence, move it 16 times more slowly. By a proper adjustment of weights, the rate of motion may be made as small as we please, or we can reduce the accelerating force to any fraction of gravity. The drawing represents the latest pattern of the machine, made by Queen & Co., and employed in experiments to establish the laws that regulate the motion of falling bodies and to illustrate various principles in gunnery. See *Falling Bodies*.

AUDITOR.—The name given to certain officers appointed to examine accounts in behalf either of the government, of courts of law, of corporations, or of private persons. In 1785 Public Auditors were appointed in England under the title of "Commissioners for Auditing the Public Accounts," by which the patents of Lord Sondes and Lord Mountstuart, as *Auditors of the Imprests*, were vacated, the sum of £7000 per annum being made payable to each of them for life, in lieu of a percentage which had been paid them on the amount of expenditure audited. Many subsequent statutes have been passed for the purpose of extending and defining the duties of these Commissioners, and regulating the business of the Audit Office. The Commissioners of Audit are empowered to call on all Public Accountants to account for moneys or stores intrusted to them; and should they fail to do so, are required to certify their names to the Remembrancer of the Exchequer, and the Attorney-General of England or Ireland, or the Lord Advocate of Scotland, in order that they may be proceeded against as defaulters. These proceedings, however, may be stayed for a time by the Lords of the Treasury, by whom the whole arrangements of the Audit Office are controlled, on the application of the accused. The accounts of the Ordnance, of the Army and Navy, and the Land Revenue are now subjected to examination in the Audit Office. In the United States, the Second and Third Auditors are officials connected with the Treasury Department, whose duties consist in examining all accounts relating to the pay and clothing of the army, the subsistence of officers, bounties, premiums, military and hospital stores, and generally all accounts of the War Department other than those provided for; also all claims for compensation for loss of horses and equipments of officers and enlisted men in the military service of the United States, pensions, etc.

AUGET—AUGETTE.—A kind of small trough used in mining, in which the saucisson or train-hose is laid in straw to prevent the powder from contracting any dampness.

AUGUSTAN SYSTEM OF FORTIFICATION.—In this system, the gorge of the tenailles is occupied by two parallel defensive barracks and by casemated redoubts. Many of the casemates here traced bear a close resemblance to the plan of Haxo. This system is so complicated as to be impracticable. See *Fortification*.

AUGUSTICUM.—A bounty that was given by the Roman Emperors to their soldiers upon the latter taking the oath of allegiance for the first time, or upon a renewal of the oath.

AULIC COUNCIL.—One of the two highest Courts of the old German Empire, co-ordinate with the Imperial Chamber. It came into existence in 1495, and seems to have been at first employed principally in preparing business matters regarding the Crown-lands and the Empire generally, in order to expedite the decisions of the Imperial Chamber. It soon, however, began to assume or acquire higher functions. After 1502, the States submitted important grievances to its independent consideration; but it did not receive a fixed Constitution before 1559. In 1654 it was formally recognized as the second of the two Supreme Courts, and equal in dignity to the Imperial Chamber. It was composed of a President, a Vice-President, a Vice-Chancellor, and eighteen Councilors, who were all chosen and paid by the Emperor, with the exception of the Vice-Chancellor, who was appointed by the Elector of Mainz. Of the eighteen Councilors, six were Protestants, whose votes, when they were unanimous, could not be set aside by those of the others, so that a religious parity was to some extent preserved. The Councilors were divided into three classes—Counts, Barons, and Men of Learning—all of whom were on a footing of equality, except that the last mentioned received a higher salary, and were usually advanced into the ranks of the nobility. The Council held aloof from politics, but under its jurisdiction were placed: (1) all matters of feudality in which the Emperor was immediately concerned; (2) all questions of appeal on the part of the States from decisions in favor of the Emperor in Minor Courts; (3) whatever concerned the imperial jurisdiction in Italy. On the death of the Emperor, the Council was dissolved, and had to be reconstructed by his successor. It finally ceased to exist on the extinction of the old German Empire in 1806.

AUMACOR.—A title similar to General-in-Chief, which was given to the Chief of the Saracens during the Crusades.

AUSEN.—A name given by the Goths to their victorious Generals. This word in their language signifies "more than mortal," i.e., demi-gods.

AUSTRIAN ARMY.—One of the four great continental armies of Europe. In December, 1868, the imperial signature was affixed to the law introducing the system of obligatory personal service for every male subject of the Austrian Empire. At present the military force of Austria is composed of the Standing Army, the Reserve, the Landwehr, and the Landsturm. The latter element means simply a *levée en masse* of the entire male population for the defense of the country in case of invasion. The total liability to military service extends over twelve years, this period being thus apportioned: three years to the Standing Army, seven years to the Reserve, and two years to the Landwehr. In countries that have adopted the compulsory service, exemptions are obtainable under the following social conditions: 1. Being the only son and support of a helpless father or widowed mother; 2. After the death of a father, being the only grandson and support of an infirm grandfather or widowed grandmother; 3. Being the only support of helpless relations. All service of a substitute or exemption by purchase is abolished. As in Prussia and France, volunteers for one year are admitted. The effective numerical strength of the Standing Army, Reserve, and Landwehr amounts to about 1,100,000 men, of which about $\frac{5}{11}$ are contributed by the first two classes, the Standing Army and Reserve, to which Hungary furnishes a quota of nearly 330,000. Austria, inclusive of Hungary, is divided into 17 military districts. The Standing Army is composed of 24 divisions, containing 52 brigades of infantry and 19 of cavalry. The infantry of the line consists of 80 regiments; the cavalry of 41 regiments (14 of dragoons, 14 huzzars, and 13 lancers), giving about 36,000 cavalrymen. The artillery consists of 12 regiments of field and 12 battalions of garrison artillery, each field-artillery regiment consisting of four 4-pdr. foot-batteries, three 4-pdr. horse-batteries, and five 8-pdr. foot-batteries. In the Austrian army, to every 1000 combatant foot-soldiers there are 103 cavalry and 4 field-guns. There are 2 regiments, of 5 battalions each, of engineers, with 4 active and 8 reserve companies, and 1 depot battalion of 5 companies. The transport service of Austria is conducted by a Military Transport Corps, which consists of 36 field-squadrons, 22 of which on mobilization are assigned to the infantry divisions, 5 to the cavalry, 4 to army corps headquarters, and 2 to general headquarters. There are, besides, the Intendance and a Hospital Corps. The Emperor is the supreme head of the Austrian army, which he governs through a Minister of War and an Inspector-general. The mode of officering the Austrian army is as follows: 1. By passing, as a Cadet, through a Military College; 2. Rising from the ranks. (1) Cadets are trained at public cost, and remain ten years in active service from the date of their leaving the Academy. After the aspirant has practically learned every duty of the private and non-commissioned officer, he attends the school which is established at the headquarters of every division. He goes then through a course of eleven months, followed by an examination. If successful, he performs the duties of an officer, though still not commissioned, and receives his commission when a vacancy occurs. (2) The preparation for promotion is also regimental, and in this manner non-commissioned officers of good character and antecedents, and of sufficient attainments, may obtain a commission. Promotion goes right through, arm by arm and rank by rank. It is by seniority and non-seniority. The former depends on the confidential reports giving testimony of the individual's efficiency, and the latter is followed every sixth step below field-rank and every fourth step above it. There is an examination twice a year for promotion. See *Army*.

AUSTRIAN FIELD-GUN.—A muzzle-loading rifled gun made of bronze. There are two sizes, the 4-pdr. and the 8-pdr.; the former for horse-artillery, the latter for field-batteries. The projectiles are iron-ribbed, not studded, for taking the rifling. The Austrians are about to change their bronze guns for steel of their own design; the proof lately of one of their guns answered all that was required of it. The gun experimented on was an 8.7-centimeter steel cannon, and is said to be an improvement on the Prussian field-gun.

AUSTRIAN RIFLING.—This system is specially adapted to gun-cotton. The bore is spiral in cross-section, increasing in diameter from the point at the end of the land, which is the bearing-side going in; all the rest of the bore is the bearing-side which rotates the shot coming out. The cast-iron projectile is covered with a soft metal coating which enters the gun freely when a projection bears against the land mentioned; but which, as the shot comes out, is compressed by the spiral bore, and shuts off the windage. To prevent the shot jamming in the bore, three grooves are introduced to receive corresponding ribs on the shot. But, the shot is centered and rotated, coming out, by the whole circumference of the bore as well as by these three grooves.

AUTHORITY.—In a general acceptation of the term, a right to command, and a consequent right to be obeyed. The Articles of War provide that when any officer or soldier is accused of a capital crime, or of any offense against the person or property of any citizen of any of the United States, which is punishable by the laws of the land, the Commanding Officer, and the officers of the regiment, troop, battery, company, or detachment to which the person so accused belongs, are required, except in time of war, upon application duly made by or in behalf of the party injured, to use their utmost endeavors to deliver him over to the Civil Magistrate, and to aid the officers of justice in apprehending and securing him, in order to bring him to trial. If, upon such application, any officer refuses or willfully neglects, except in time of war, to deliver over such accused person to the civil magistrates, or to aid the officers of justice in apprehending him, he shall be dismissed from the service.

AUTOCRACY.—A term signifying that form of government in which the Sovereign unites in himself the legislative and the executive powers of the State, and thus rules uncontrolled. Such a Sovereign is therefore called an Autocrat. Nearly all Eastern governments are of this form. Among European rulers the Emperor of Russia alone bears the title of Autocrat, thus signifying his constitutional absoluteness.—Kant used the word Autocracy, in philosophy, to denote the mastery of the reason over the rebellious propensities.

AUTOGENIC PLUMBING APPARATUS.—This apparatus is a modification of the oxy-hydrogen blow-pipe. It has been in use for some years by manufacturing chemists, etc., in the construction and repair of leaden utensils. Its purpose is to provide, by means of the reaction between oil of vitriol, water, and zinc, a supply of hydrogen gas, and, after mixing it with air, to burn the mixture at the end of a blow-pipe nozzle, and by means of flexible rubber tubing apply the flame readily to the work in hand. By its aid lead sheets, pipes, etc., may be joined together by melting the points of junction, without the use of solder or flux. It can also be used for soldering, brazing, and annealing; in fact, for any purpose requiring an intense heat locally applied. It consists of a rectangular box divided into two closed compartments. The upper one is an acid-chamber, opening at the top, and a pipe connects it with the bottom of the lower compartment. The lower compartment is the zinc- and gas-chamber, having a pipe near its top to convey the gas generated into a purifier arranged in the space between the upper and lower compartments. This space also contains the opening into the lower compartment, through which the zinc is inserted The dilute acid runs down the pipe from the upper chamber into and up through the zinc in the lower chamber, in the upper part of which the gas collects and passes out by a bent pipe into the bottom of the purifier. The purifier is a box intended to collect any drips which may pass over with the gas. From its upper part a pipe conveys the gas to the bottom of a second purifier, filled with water, through which the gas rises and passes to the blow-pipe. The water removes any sulphurous-acid gas or other impurities that may pass over with the hydrogen gas. The rear end of the blow-pipe is divided into two branches. To one of these the tube conveying the hydrogen is attached, and to the other a tube conveying air driven in by a bellows. The hydrogen and air combine and mix in the blow-pipe and flow out of its nozzle when the mixture is ignited for application of the flame to the work. Lead sheets may be joined edge to edge or by a lap. In the former case lead straps are melted along the joint to perfect and strengthen it. The apparatus is much used in arsenals for lining pickling-vats, floors covered with lead, etc.; also for annealing the serrated wires for friction-primers, and for soldering and brazing.

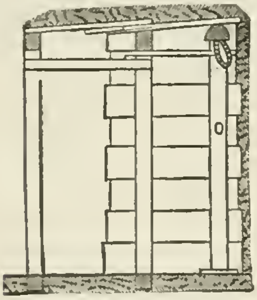
AUTOMATIC FIRE.—The automatic fire or explosive mixture of the Greeks was made from equal parts of sulphur, saltpeter, and sulphide of antimony, finely pulverized and mixed into a paste, with equal parts of the juice of black sycamore and liquid asphaltum, a little quick-lime being added. The rays of the sun would set it on fire.

AUTONOMY.—The arrangement by which the citizens of a State manage their own legislation and government; and this evidently may, with certain restrictions, be the case also within limited bodies of the same people, such as parishes, corporations, religious sects. The term Autonomy is used to designate the characteristic of the political condition of ancient Greece, where every city or town community claimed the right of independent sovereign action. The idea of two or more town communities sinking their individual independence, and forming the larger aggregate unity which we understand by a State, seems to have been intolerable to the Greek mind.

AUXILIARY FORCES.—The Militia, Yeomanry, and Volunteers of Great Britain. These forces aggregate as follows:

	Officers	Men.	Total.
1. *Yeomanry*, 40 regiments........	804	14,274	15,078
2. *Militia*:			
Artillery, 29 regiments.........	3497	16,422	139,619
Infantry, 131 battalions........		119,700	
Total...............	4301	150,396	154,697
3. *Volunteers*:			
Artillery..........................	Separate numbers are not given.		31,823
Cavalry: Light horse, 4 regiments.			366
Cavalry: Mounted rifles, 4 regiments			139
Engineers.......................			6,296
Infantry.................. ...			128,669
Permanent Staff...............			1,458
Total...........		......	168,751

AUXILIARY FRAME.—When mining in loose soils, besides the ordinary gallery-frame, there is re-



Auxiliary Frame.

quired, as for shafts in the same soils, an auxiliary gallery-frame. This frame, shown in position, in the vertical section of the gallery through the axis, in the drawing, is somewhat wider than the ordinary gallery-frame, and somewhat shorter also. Its cap-sill is rounded on top, and has two mortices on its lower side, to receive the tenons with which the two stanchions are finished. The mortices are a little longer than the tenons; the latter being confined in them by wedges when the frame is set up. To adjust the frame when set up, a pair of folding wedges is placed under each end of its ground-sill. By these contrivances the frame can be readily set up or taken apart. See *Gallery* and *Shaft*.

AUXILIARY TROOPS.—Foreign troops which are furnished to a belligerent power in consequence of a treaty of alliance, or for pecuniary considerations. Of the latter description may be considered the Hessians that were employed by Great Britain to enslave America.

AUXILIARY WAR.—A war in which a nation succors its neighbors, either in consequence of alliances or engagements entered into with them, or sometimes to prevent their falling under the power of an ambitious Prince.

AVANT-BRAS.—Guards for the lower arms, worn by knights and soldiers in the Middle Ages.

AVIS—AVIZ.—An order of knighthood in Portugal, instituted by Sancho, the first king of Portugal, in imitation of the Order of Calatrava, and having, like it, for its object the subjection of the Moors. By the present usage, the king of Portugal, who is grand-master of all of them, wears decorations of the first three orders of Portugal—those of Christ, St. James, and Aviz united in one medal, divided into three equal spaces.

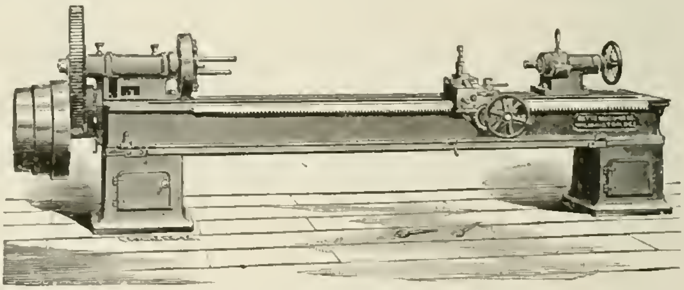
Badge of Order of Aviz.

AWARD.—A judgment, the result of arbitration. In a military sense, the decision or sentence of a Court-Martial.

AXIS.—A straight line, real or imaginary, about which a body revolves is called the axis of rotation. In gunnery, the axis of the piece is the central line of the bore of the gun.

AXLE-LATHE.—A lathe much used in arsenals for turning axles, shafting, and other relatively long articles which are liable to be swayed or bent by their flexibility or by the pressure of the cutter. Bearings are provided at points between the lathe-centers, and sometimes the cutters are duplicated so as to act upon opposite sides simultaneously. The axle or shafting is turned to form by suitably shaped cutters secured to two jaws, which approach each other by the rotation of a right- and left-hand screw in a fixed rest. Whitworth's famous lathe is of this character.

The drawing shows the form of lathe in general use. It swings 16 inches diameter over the shears, and 14 inches diameter over the rest-carriage; the



Axle-Lathe.

cone pulleys have three speeds for a 4-inch belt, which, with the two sets of fast and loose pulleys on the countershaft, give six changes on the face-plate; it has cast-steel spindles running in gun-metal boxes; the dead-spindle is secured by a patent conical binder; the rest-carriage has a hand-movement by a rack in the bed; its feed is by a screw and cut cog gearing with two changes, operated by a clutch and rod, for roughing and finishing; adjustment to dead-head for turning taper, and has Clement's driver. With 12-foot shears, to turn 8½ feet long, the weight is 5700 pounds. See *Lathe*.

AXLE-TREE.—A solid bar or beam, so shaped as to receive at each of its extremities a wheel, which revolves freely about it. Those parts about which the wheels revolve are called the *arms* or *axle-tree arms*. The part of the axle-tree between the arms is called the *body;* that portion of the body contiguous to the arm is the *shoulder;* and the extremity of the arm is its *point*.

AXLE-TREE ARM.—That portion of an axle-tree about which the wheel revolves. The *axle-tree arm* is circular in section, and near its outer extremity is a vertical hole to receive the linch-pin, which keeps the wheel on the arm.

AXLE-TREE BED.—A wooden beam or block intermediate between the axle-tree and the body of the carriage. In the usual constructions it is kept in contact with the body of the axle-tree along its entire length, the body being housed or let into it from end to end. In this connection side-thrusts exert hardly any injurious moment about the junction between axle-bed and body, the length of this connection being considerable as compared with the length of the lever-arm $R + d$ (R being the height of the axle-arm above the ground, and d the depth of the axle-tree bed); but any tractional moment, $Pd\frac{(2aR - a^2)}{R^2}$ (a being the height of the obstacle, and P the measure of blow upon the tire in direction parallel to the road), must be guarded against by bands, knees, or connecting stays.

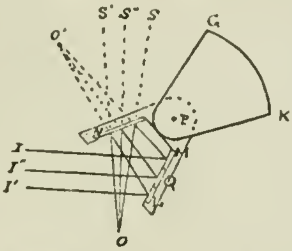
AYA-BASSI.—A non-commissioned grade in the corps of Janissaries, corresponding to that of Corporal in modern armies.

AYENEE.—A tree which grows in the forests of Southern India, Godavery, and Burmah; the wood is strong, tolerably close, even-grained, and of a light yellowish color. It is a wood that may be used for gun-carriage purposes.

AZAINE.—A name anciently applied to a trumpet in the French army; now obsolete.

AZAPES.—Auxiliary troops which were levied by the Turks among the Christians (under their dominion), whom they exposed to the first attack of the enemy.

AZEMAR TELEMETER.—Of the mirror-telemeters giving fixed angles, that of Azémar seems to be the simplest. This is made to give two angles, one acute and the other obtuse, supplements of each other. It is shown in the drawing with the addition of an additional fixed mirror for giving a right angle. If only two angles are used, an acute combined with a right angle would be better than the two supplementary angles, as the advantage of having a right angle would be secured without necessitating back-sights in observation.



The modified Azémar telemeter consists of a small frame, L M N, on which are placed four plane mirrors reaching from the top to the bottom of the frame; this frame swinging between two plates of brass, G K, it being pushed out and in by turning it about the pivot P. The mirrors L, Q, and M make with the mirror N angles less than, equal to, and greater than 90 respectively—the greatest and least angles being complements of each other. Such a telemeter commends itself by its cheapness, but a prism-telemeter gives far greater clearness to the image, while, unlike the mirror-telemeter, it is not subject to derangement. See *Telemeter*.

AZURE.—A French word technically used in Heraldry to signify blue. In engraving arms it is always represented by horizontal lines.

B

BABOOL.—A tree which is found in different parts of India. The wood is close-grained and tough, of a pale red color, inclining to brown. It is used in the gun-carriage agencies of Madras and Bombay for naves and felloes of wheels. This tree, which grows in abundance in the northwest of India, forms the staple food of the camel.

BACCHI.—Two ancient warlike machines; the one resembled a battering-ram, the other cast out fire.

BACHELIER.—A young squire, or knight, who has passed through his first campaign, and received the belt of the Order.

BACHEVALEUREUX.—A term which, in the old French language, signified warrior, brave, valiant, etc.

BACK.—A cast-iron plate forming the back wall of a forge, and through which the blast enters by a *tuyere*. When the back consists of an iron cistern, it is called a *water-back*. When it consists of a chamber in which the air-blast is heated, it is called a *heating-back*.

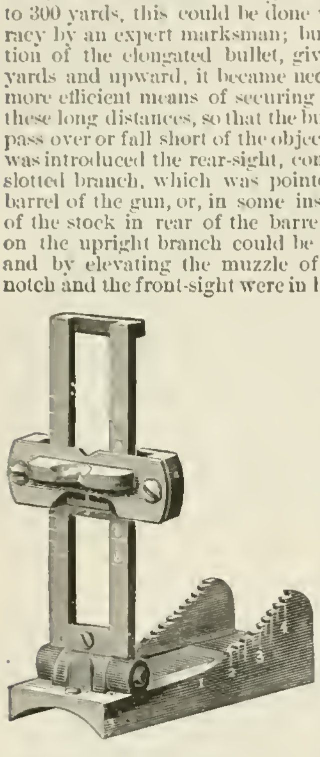
BACK-BAND.—The band or strap which passes over the back of the horse and meets the belly-band; the two unite to girth the horse.

BACKING.—Experiment has shown that wood-backing alone, unless combined with rigid horizontal angle-iron stringers, affords but little support to the armor-plate; that is to say, a projectile which is capable of penetrating a plate unbacked will also be capable of doing so if it be backed with wood alone. Wood-backing is, however, of great value because it distributes the blow; it deadens the vibrations and saves the fastenings; also it stops the splinters. The best form of backing appears to be that in which wood is combined with strong horizontal angle-iron attached to the inner skin, and extending to the armor-plates; this, by giving rigidity, very considerably assists the plate to resist penetration. An inner skin of iron is of the greatest possible advantage; it renders the backing more compact, and prevents the passage of many splinters. Oak and teak are the most suitable timbers for backing-plates, and are used as such on vessels. A yielding backing is found to occasion less strain on the fastenings than a very hard one. Where projectiles are made of the same material, and are similar in shape, their penetration into unbacked plates is nearly in proportion to their *living force, or their weight multiplied by the squares of the velocity of impact.*

The resistance which an unbacked plate offers to penetration is nearly in proportion to the *square of its thickness*, provided this thickness be confined within ordinary limits. In the case of oblique plates the penetration diminishes nearly with the *sine of the angle of incidence*. The most suitable material for shells to be used against iron plates is tempered steel. These projectiles should be made of cylindrical shape with thick sides and bottom to direct the explosive effect of the charge forward after penetration is effected. The most suitable material for solid shot is hard, tough cast-iron. Palliser's chilled shot are made of this material, and so are the shot made for our service. It follows from the preceding that the most suitable covering or shield for cannon is a conical-shaped turret made of wrought-iron plates, as large as it is practicable to make them, backed with oak or teak. To protect the men from the fragments of projectiles which may penetrate completely through this covering, there should be an "inner skin" of thick boiler-plate placed behind the wood. With our 15-inch cast-iron projectiles, made of the best charcoal-iron, poured and worked in a peculiar manner so as to obtain hard and solid masses, the penetration is quite as great and uniform as that obtained with *steel* shot of equal weights propelled by similar charges, the only difference being that the iron breaks after passing through, while the steel is only compressed or flattened, a result rather in favor of the iron shot, if entrance is made where men are exposed to its fragments.

BACK-PLATE.—A piece of armor for covering the back. See *Armor.*

BACK-SIGHT.—The rear-sight of a gun. It may be of various forms. In the old-fashioned arms intended for round balls, it was merely a notch in a knob or plate near the breech of the gun, the proper elevation to be given being estimated by the marksman. As the effective range scarcely exceeded 250 to 300 yards, this could be done with sufficient accuracy by an expert marksman; but with the introduction of the elongated bullet, giving ranges of 1000 yards and upward, it became necessary to seek some more efficient means of securing the proper range at these long distances, so that the bullet might not either pass over or fall short of the object. For this purpose was introduced the rear-sight, consisting of an upright slotted branch, which was pointed to a seat on the barrel of the gun, or, in some instances, on the small of the stock in rear of the barrel. A notched slider on the upright branch could be elevated as desired, and by elevating the muzzle of the gun until this notch and the front-sight were in line any range within the limit of projection of the piece could be attained. This sliding sight has, in the United States service, been superseded by the leaf-sight, which is more compact and less liable to derangement. Other back-sights, especially those first introduced in southern Germany, have been made of various patterns; one variety being permanently fixed perpendicularly to the barrel, and having notched holes at proper heights through which to sight; and another being segmental in shape, and moving circularly in a direction longitudinal to the barrel through a stud fixed thereon. Another form of back-sight vertically adjustable for range, and attached to the stock, has a graduated spring-piece slipping within a vertical slot in the small of the stock, and is adjusted as required. Its spring retains it in place, or it may be clamped by a set-screw or lowered below the line of the hind-sight on the barrel. The drawing shows the back-sight (with wind-gauge) used on the Winchester military rifle. See *Pointing.*



BACK-STEP.—The retrograde movement of a man, or a body of men, without changing front.

BACK-SWORD.—A sword with one sharp edge in contradistinction to one which has two edges throughout the whole or a portion of its length. In England, the *back-sword* is a stick with a basket-handle, used in rustic amusements; called also "Single Stick."

BACKWARDS.—A technical word made use of in the British service to express the retrograde movement of troops from line into column, and *vice versa.* Also, a word of command, in the United States service, to cause a man, or a body of men, to march to the rear without changing front.

BACULE.—A kind of porteullis or gate, made like a pitfall, with a counterpoise. See *Bascule Bridge.*

BADALEERS.—Musket-charges of powder in tin or copper tubes, worn dangling from a shoulder-belt, before the introduction of cartridges.

BADELAIRE.—A short, broad, curved, and double-edged pointed sword. Also written *Bandelaire.*

BADEN FUSE.—A modification of the Bormann fuse. The metal, form of the parts, etc., are the same as in the Bormann fuse, with the addition of a bronze stud and plate, used to confine a piece of quick-match in the recess shown at *b* (see Bormann fuse), and two pieces of common cartridge-paper, cut in the proper shape to fit the horseshoe-shaped opening, one of which goes above, the other below, the charge of composition, to prevent it, when burning, from melting the metal above and below it. The graduated scale is more extended than in the Bormann fuse, the numbers expressing, instead of seconds, the bursting-distances in hundreds of paces of 29½ inches in length. The *charge-cover* is cast in a mold; the plate to cover the priming is cut out with scissors, and the paper is stamped or cut out with a stamp or punch. The vent leading from the composition-channel to the magazine is closed, to prevent the entrance of composition when pressure is applied. One of the pieces of paper is now laid in the bottom of the channel, and on it is placed evenly a layer of mealed powder, weighing exactly 51 grains troy; on top of this is placed the second piece of paper, and then the charge-cover, which is pressed down to its place by machinery, having on its under surface the dies to impress the figures of the graduating scale on the metal. The amount of pressure exerted is about 5000 lbs.; which forces the top of the charge-cover slightly below the surface of the fuse, forming thus a shallow annular hollow, in which is poured some of the melted metallic mixture, but at as low a temperature as possible, in order that the heat of this solder may not act on the sulphur in the fuse. When cool, the fuse is placed in a turning-lathe, dressed off smooth, and any irregularities in the thread of the screw corrected. The vent is then unstopped, the magazine filled with fine powder, the cover placed on, fastened, and pierced.

This fuse, like the original Bormann, was designed for use with Shrapnell shot, and is always used with what the French call an *obturateur,* or stopper, which is made usually of wrought-iron. The eye of the shell is divided into two parts, the larger on the exterior (called the eye proper), and the contracted portion, next to the interior, called the *table.* Into this latter the obturateur is screwed, and serves, with the offset between the two, to prevent the soft metal of the fuse from being driven into the shell by the force of the charge. The obturateur is perforated through the center, to allow the passage of the flame into the charge. The weak point of this fuse, and all modifications of the Bormann fuse, is the difficulty of regulating them exactly and promptly on the field of battle, in a dense cloud of smoke, and especially at night. A remedy for this defect, however, has been found in the ingenious invention of Captain Breithaupt, of the Austrian service. See *Breithaupt Fuse.*

BADGE.—The term by which, in general, all honorary decorations and special cognizances are known. Badges are either conferred by the State or Sovereign, or assumed by the individual for purposes of distinction, the former class having very frequently had their origin in the latter. Of badges conferred by public authority, for the purpose of inciting to exertion and gratifying honorable ambition, numerous instances are to be met with in every part of the world. The Garter of the English knight, the Golden Fleece of the Spanish grandee, and the Button of the Chinese mandarin will occur as familiar examples. To the same class belong not only the Stars and Crosses with which princes and other persons of rank are adorned in England, and to a far greater extent on the Continent, but the medal of the private soldier, and even those not less honorable decorations which are now frequently conferred by private societies for acts of voluntary daring, such as the medal given by the Humane Society for saving from drowning. Amongst the ancients, one of the most usual emblems of authority was a gold ring, which was worn generally on the fourth finger. A ring of this description was the mark of senatorial and magisterial dignity, and latterly of knighthood at Rome; iron rings, during the earlier period, at all events, having been used by private citizens. The right of wearing a gold ring (*jus annuli aurei*) was gradually extended, till at length Justinian conferred it on all the citizens of the Empire In the early times of the Republic, when Embassadors were sent to foreign States, they were furnished with gold rings, which they wore during their mission as badges of authority. From an early period, every freeman in Greece appears to have used a ring, though the custom, not being mentioned by Homer, can scarcely have belonged to the earliest period of the history of that people, and is commonly supposed to have been of Asiatic origin. Rings are often mentioned in Scripture as badges of authority both amongst the Jews and other Oriental nations. We read of Pharaoh taking off his ring and putting it on Joseph's hand, as a token of the power which he committed to him (Gen. xli. 42); and still earlier (Gen. xxxviii. 18) Judah left his signet with Tamar as a pledge. In the New Testament, rings are spoken of rather as marks of wealth and luxury than as badges of official rank; e.g., James ii. 2, and Luke xv. 22, where, on the return of the prodigal son, the father ordered that a ring should be put on his finger. Of badges assumed for the purpose of distinction, none are more famous than the white and red roses of York and Lancaster. Henry VII. combined these two emblems, first carrying a rose per pale, white and red, and afterwards placing the white rose within the red one. One of Queen Elizabeth's badges was a golden falcon perched on the stump of a tree between two growing branches of white and red roses, a badge which is said to have been given to her mother. Anne Boleyn, by Henry VIII. The *bear and ragged staff*, which still exists as a sign in London, was the badge of the great Earl of Warwick. The *white hart* and *silver swan*, which are frequently met with as signs to inns, have a similar origin, the first having been the badge of Richard II., and the second having belonged to the House of Lancaster. The *garb and sickle*, the badge of the Hungerfords, is another very

Garb and Sickle.

Fleur-de-lis of Louis VII.

beautiful and less common example of the same class of badges. Different countries have also distinctive badges, generally connected with the history either of the actual ruling or of some former dynasty. Of these, the *fleur-de-lis* of France, and the other badges. for which it from time to time makes way—viz., the cap of liberty and other emblems of republicanism, the eagles of the Empire, borrowed from Rome, and the bees and other insignia which the Bonaparte family have assumed—may all be taken as examples.

For the badges of the different Orders of Knighthood, see their respective titles.

BAGGAGE.—No question is more important in giving efficiency to an army than the regulation of its baggage. Nothing so seriously impairs the mobility of an army in the field as its baggage-train, but this baggage is necessary to its existence; and the important question therefore arises, How shall the army be sustained with least baggage? Sufficient attention is not paid by Government to this subject in time of peace, and in war the Commander of the troops finds himself therefore obliged to use the *unstudied* means which his Government hastily furnishes. In respect to artillery and artillery equipments, the minutest details are regulated. It should be the same with other supplies. In the United States Army, the Quartermaster's Department has charge of transports, and some steps have been taken to regulate the subject; but legislation is required for the necessary military organization of Conductors and Drivers of wagons, and perhaps, also, unless our arsenals may be so used, for the establishment of depots, where a studied examination of field-transportation may be made, which will recommend rules, regulating the kinds of wagons or carts to be used in different circumstances; prescribing the construction of the wagon and its various parts in a uniform manner so that the corresponding part of one wagon will answer for another, giving the greatest possible mobility to these wagons consistent with strength; prescribing the harness, equipment, valises of officers, blacksmith-forges, tool-chests, chests for uniforms, bales of clothing, packing of provisions, and, generally, the proportion, form, substance, and dimensions of articles of supply,; what should be the maximum weight of packages; the means to be taken for preventing damage to the articles; the grade, duties, and pay of the Quartermasters, Wagon-masters, and Drivers should be properly regulated; rules for loading should be given; and, finally, a complete system of marks, or modes of recognition, should be systematized. With such rules, and the adoption of a *kitchen-cart*, together with small cooking-utensils for field-service which may be carried by the men, an army would no longer always be tied to a baggage-train, and great results might be accomplished by the disconnection.

In the marching arrangements of the British Army the baggage is placed under strict rules, in order that accumulation of weight may not impede the movement of the troops; and rules of an analogous kind are enforced in troop-ships, when soldiers are on a voyage. The term itself is made to apply chiefly to articles of clothing, and to small personal effects. A private soldier is allowed to carry nothing except that which his knapsack and other accouterments can hold; but those who are married with their officers' consent —a small number in every regiment—are allowed one small chest each, of definite size, which may be carried on a march, but at the men's own expense. Staff-sergeants and Pay-sergeants have similar permission. The baggage-wagons are not expected to receive packages weighing more than 400 lbs. each, or as much as four men can lift. Officers' baggage is, of course, much more considerable in amount than that of the non-commissioned officers and privates. On board troop-ships, the weight to be carried for each person is strictly defined—from 18 cwt. for a Field-officer, down to 1 cwt. for a married private soldier, with his wife and children. In encampments, whether permanent or temporary, and in armies on field-service, the utmost care is taken to preserve the baggage from the enemy, by surrounding it as much as possible with defensive troops.

BAGGAGE - MASTER.—An officer, in the English Army, appointed to take charge of the baggage of each brigade and division of an army in the field. He is selected from the Line if the Senior Officer of the Army Service Corps is not suited for the work. During the march he is the Staff-officer of the Field-officer of the Day, who, commanding the rear-guard, can give him orders if necessary. The Queen's Regulations of 1873 state that each regiment on a march is to furnish its own baggage-guard, under the care of an officer of the regiment.

BAGGONET.—The ancient term for bayonet. It is seldom used at present.

BAGPIPE.—A wind-instrument, very popular in the Highlands of Scotland. This instrument, the performers of which are called "pipers," is played by the bandsmen of Highland regiments. Up to the eighteenth century, the bagpipe was a very common instrument over the greater part of Europe. It is supposed to be of Grecian origin, and the Romans in all probability took it from the Greeks. The natives of India have an instrument very similar to the bagpipe. The bagpipe has long been a favorite instrument with the Scots, inspiring them with great enthusiasm and valor in the day of battle.

BAGS.—Articles used in field-fortifications, and in works to cover a besieging army. *Sand-bags*, which are generally 16 inches in diameter and 30 high, are filled with earth or sand, to repair breaches and embrasures of batteries, when damaged by the enemy's fire or by the blast of the guns. They are also placed on parapets, so arranged as to form a covering for men to fire through. *Earth-bags*, holding a cubical foot of earth, are used to raise a parapet in haste, or to repair one that is beaten down. They are only employed where the ground is rocky, or too hard for the pickaxe and spade, and does not afford ready material for a temporary parapet. See *Blowing-bags*, *Bursting-bags*, *Calico-bags*, *Cartridge-bags*, *Gunny-bags*, and *Gunpowder-bags*.

BAGS OF POWDER.—Powder in bags used to blow down gates, stockades, and slight obstructions. In future wars the higher explosives will doubtless be used for such purposes.

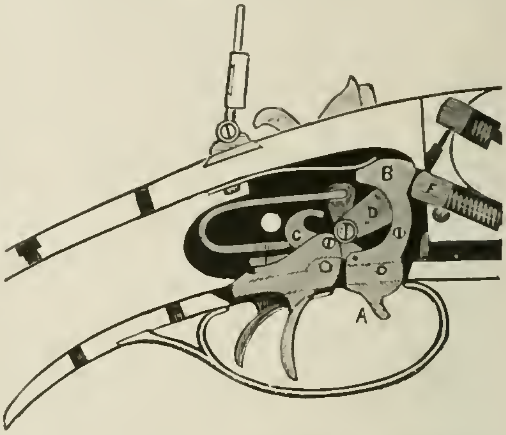
BAICLAKLAR.—The name given to a Color-bearer in the Turkish Army.

BAIKY.—The ballium, or inclosed plot of ground in an ancient fort.

BAIL.—A stout iron yoke placed over heavy guns and fitting closely over the ends of the trunnions, to which it is attached by pins in the axis of the trunnions; used to raise or lower the gun by means of the gin.

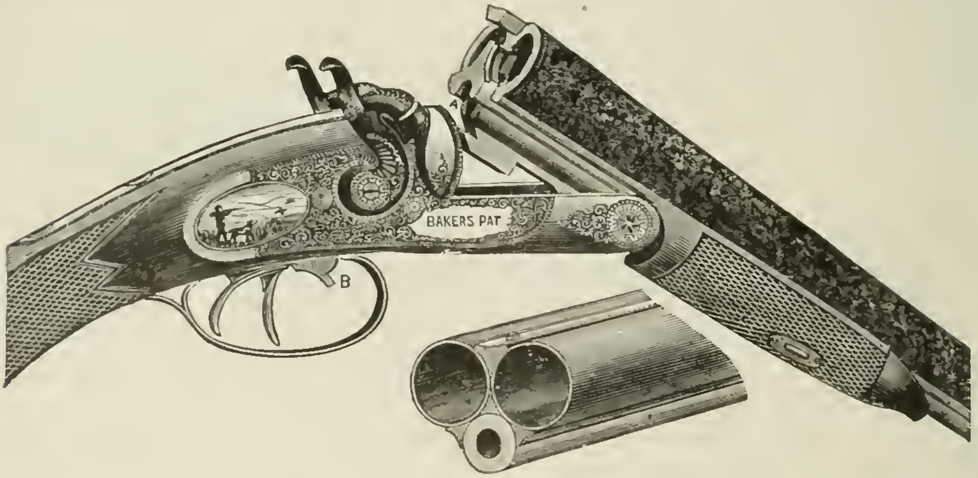
BAILLE.—A term formerly used to designate a work or fortification which served as an outpost or exterior defense.

though the same weight of metal was put in one barrel, which may be accounted for by the fact that the same weight of metal in a hollow tube is much stiffer than though it was in a solid bar; and, also, each barrel forms a brace to help support the other, and especially in regard to the rifle-barrel, in which



are used the heaviest charges that are manufactured for a sporting-gun.

The drawings show the form of the gun and the manner of operating the mechanism. In the smaller drawing, A is the rifle hammer which, being hung in the trigger-plate and extending up its side between the two shotgun locks, strikes the rifle firing-pin at



A, Rifle Barrel; B, Thumb-piece of the Rifle Hammer.

BAIONNIER.—A name formerly given to soldiers who were armed with a bayonet.

BAKER GUN.—A three-barrel breech-loading gun recently introduced and received with much favor. As happens to every hunter or sportsman, unexpected opportunities offer themselves to shoot at a class of game that a shot-gun will either not reach at all, or fail to kill. This gun gives confidence to those hunting in localities where there are dangerous animals, or where an enemy might be lurking and unexpectedly encountered at any moment. It is a most useful and suitable weapon for the hunters attached to scouting columns in the field, who are charged with supplying the messes with game. The weight, not over nine pounds, is sufficient to prevent an unpleasant recoil, and permits the gun to be carried with the same case as does an ordinary rifle, containing metal enough to do satisfactory work.

It is demonstrated by actual use that there is less spring or recoil in a gun with three barrels than

B. To operate it, cock the left-hand shot-gun lock and then push forward the thumb-piece, A, of rifle hammer, which will cause the hook, C, to engage with the pin, E, which is attached to the tumbler of the left-hand lock; then by pulling the back trigger the rifle hammer will be caused to strike the firing-pin at B, and stop, thus not allowing the left-hand hammer to go quite far enough to reach its firing-pin. After firing the rifle, cocking the left-hand hammer throws the rifle lock out of gear, then the shotgun locks are entirely independent of the rifle lock. The rifle barrel is chambered to use the Winchester 44-caliber cartridge.

The gun has a hinge-sight on the stock which turns down entirely out of the way while shooting the shot-barrels, and when turned up has a slide with a common notch in the top for open or quick shooting, and when raised has a fine hole or peep-sight for close or target shooting. A buckhorn sight can be placed on the rib when desired, but in most cases is unadvisable, as the rear-sight answers all practical purposes.

The lock is so constructed that while it retains the identical form of the best forward-action locks, making the gun the same shape, and having the same appearance outside of the finest standard work, the mainspring, instead of running forward into the breech, is inclosed within the lock-plate, which leaves the breech to retain the entire strength of the metal which has to be removed to make room for the ordinary lock, and which weakens it most precisely where it is subject to the greatest strain. While the lock thus allows of absolutely the strongest breech possible to get on a gun, it also admits of obtaining the easiest access to the entire working-parts of the gun, and is of such construction that with ordinary usage it will not get out of order, or become clogged with dirt or oil so as to prevent its successful working.

It will be seen, by referring to the description of the action, that while it is composed of the fewest pieces that is possible to use in a snap-action, it at the same time possesses every quality that is desirable, or that has been found essential to strength, durability, and safety. It is impossible to fire the gun unless the bolt is securely in its place, and the act of pulling the trigger holds it there while the gun is being discharged. It is also manifest that as soon as the gun is fired the hand is in place to open it without any change of position, insuring easy manipulation and rapid firing, it being entirely practicable to open it ready to receive the cartridge while bringing it down from the shoulder.

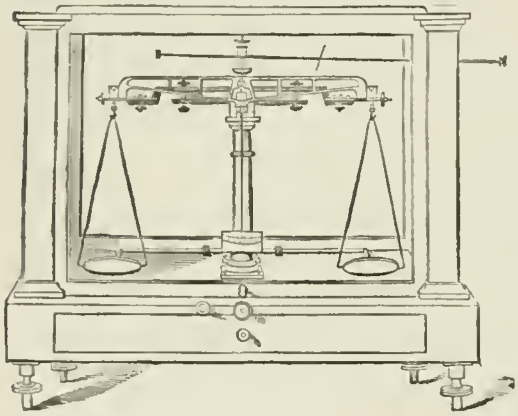
BAKERIES.—Armies have generally the means of obtaining soft or loaf bread, though not till recently could this be said of the British Army. The French, ever since the time of Louis XIV., have been accustomed to take portable ovens with their armies; those now used will each bake 450 rations at once. Outside Sebastopol, in the winter of 1854, the British soldiers sometimes willingly exchanged with the French 3 or 4 lbs. of biscuit for 1 lb. of soft bread. The efforts since made to improve the sanitary condition of the army have included the establishment of traveling-bakeries for field-service. Under the Commissaries, the troops now rarely fail to obtain their daily rations of fresh-baked bread. The English were the last among the greater nations to make this obvious improvement; but the French depend more on bread and less on meat than the English; and this may partly account for the difference. The French soldiers are taught to construct field-ovens, and to bake their bread in camp, while government bakeries are established all over France, entirely conducted by soldiers. Among other lessons afforded by the Siege of Sebastopol was one relating to an improved supply of army-bread. Two screw-steamers, the *Bruiser* and the *Abundance*, were sent out to Balaklava, one provided with machinery for grinding corn, and the other with machinery and ovens for making and baking bread. In each case the ship and the machinery were propelled by the same steam-engine. When quietly anchored in the harbor, the mill ground 24,000 lbs. of flour per day—better in quality and cheaper than could have been obtained by contract. The bakery-ship *Abundance* had four ovens of 14 bushels' capacity each; it baked in an excellent manner 6000 loaves of 3 lbs. each per day, which loaves were sent up to the siege-army as soon as cooled. The ships and machinery were sold when the war was over—a proceeding which the Commissariat Officers much regretted; but the experience thence obtained will not be lost. The improved arrangements suggested for meat-rations are noticed under *Cookery*.

BAKER RIFLE.—In 1800, the 95th Regiment, now the Rifle Brigade of England, was armed with this rifle, which weighed 9½ pounds. The barrel was 2½ feet in length and had 7 grooves, making a quarter turn in the length of the barrel, and its caliber was a 20 bore. A small wooden mallet was supplied with this rifle, to force the ball into the barrel; this mallet remained in use for a short time, when it was withdrawn. The great difficulty experienced in loading the rifle led to the remedy of M. Delvigne in 1826.

BALANCE.—An instrument for ascertaining the weight of bodies in grains, ounces, pounds, or any other units of weight. The ordinary balance consists of a lever called a beam, whose point of support is in the middle of its length, and having dishes or scales suspended from either extremity. As it is of importance that the beam should move easily round its point of support, it rests on polished agate or steel planes, by means of knife-edges of tempered steel, which project transversely from its sides, and serve as the axis of rotation. By this arrangement the surface of contact is reduced to a mere line, and the friction of the axis of the beam on its support almost entirely obviated. The scales are hung by means of chains attached to steel hooks, which rest also on knife-edges, but turned upwards instead of downwards as in the first case. The essential requirements of a balance of this description are: 1st, That the beam shall remain in a horizontal position when no weights are in either scale; and 2d, That the beam shall be a lever of equal arms, or have the distances between the central knife-edge and those at either end exactly the same. To insure the first of these conditions, it is necessary that the center of gravity of the beam lie vertically below the point of support, when the beam is horizontal. When such is the case, the center of gravity at which the weight of the beam may be considered to act oscillates as in a pendulum round the point of support, and always comes to rest right under that point, thus restoring to the beam its horizontal position when it has been tilted out of it. If the center of gravity were above the point of support, the beam would topple over; and if it coincided with that point, there being no restoring force, the beam would occupy indifferently any position into which it was thrown, the balance in both cases being useless. That a balance possesses the second of the above conditions is ascertained by putting weights into the scales which keep the beam horizontal, and then transposing them, when, if it still remains so, the lengths of the arms are equal. Should the arms be of different lengths, a less weight at the end of the longer arm will balance a larger weight at the end of the shorter arm; but when transposed, the larger weight having the longer arm, and the smaller weight the shorter, the beam can no longer remain horizontal, but will incline towards the larger weight. A balance with unequal arms is called a *false balance*, as distinguished from an equal-armed or just balance. When weighing with a false balance, it is usual to weigh a body in both scales, and take the arithmetical mean—that is, half the sum of the apparent weights for the true weight. This is near enough to the truth when the apparent weights differ little from each other; but when it is otherwise, the geometrical mean must be taken, which gives the exact weight in all cases.

Although the preceding conditions are of essential importance, they do not supply all that we look for in a good balance. It is necessary, in addition, that the beam should turn visibly from its horizontal position when there is a slight excess of weight in the one scale as compared with the other. This tendency is termed *sensibility*, and depends upon the weight of the beam, the position of its center of gravity, and the length of its arms.

There is another form of delicate balance employed in the arsenal and laboratory. The beam is constructed so as to combine lightness with strength, and rests by a fine knife-edge on an agate plane. It is surmounted by a weight moving on a screw, so that the sensibility may be increased or diminished, according as the weight is raised or depressed. In order that the knife-edge may not become blunted by constant contact with the supporting plane, a cross-bar, with two projecting pins, is made to lift the beam from the plane, and sustain its weight when the balance is not in play. The beam is divided by lines marked upon it into ten equal parts, and a small weight made of fine wire bent into the form of a fork, called a rider, is made to slide along to any of the divisions. If the rider be, for instance, $\frac{1}{10}$ of a grain, and if, after the weight of a body is very nearly ascertained, it brings the beam, when placed at the first division next the center, exactly to its horizontal position, an additional weight of $\frac{1}{100}$ of a grain will be indicated. The use of inconveniently small weights is, by this arrangement, to a large extent obviated. As the beam takes some time before it comes to rest, it would be tedious to wait in each case till it did so, and for this reason a long pointed index is fixed to the beam below the point of suspension, the lower extremity of which moves backward and forward on a graduated ivory scale, so that when the index moves to equal distances on either side of the zero-point we are quite certain, without waiting till it finally settles, that the beam will be horizontal. The same is seen in ordinary balances, only the tongue or index is above the beam; and according to its deviation on each side of the fork or cheeks by which the whole is suspended is the future position of the beam ascertained. The finer balances are never loaded to more than a pound in each scale, and when so charged will deflect with $\frac{1}{100}$ of a grain of



additional weight in one of the scales, or will turn, as it is technically called, with $\frac{1}{115200}$ of the load. The finest balances turn with $\frac{1}{1000000}$ of the load, and some have been constructed which turn with much less. Even with the best achievements of mechanical skill, no balance can be made whose arms are absolutely equal; and to remedy this defect, the method of double-weighing is resorted to when the utmost accuracy is demanded. This consists in placing the body to be weighed into one scale, and sand, or the like, into the other, until exact equilibrium is obtained, then removing the body, and putting weights or another body in its place which exactly counterbalance the sand. Both being thus weighed in precisely similar circumstances, must weigh precisely the same.

The balance employed in the process of determining density is a simple beam-scale, constructed with great accuracy. The great convenience of a decimal system of weights has led to the adoption of the scale of grams in ascertaining the density of powder. The set of weights used is of 5000 grams; approximately 11 pounds. The heaviest, 1 kilogram, 2.204 pounds; the lightest, 5 centigrams, 0.75 grain. The powder to be tested, if of mammoth size, will require breaking up to a smaller granulation; for in its natural state it will not readily enter the vase, which is of but one half-inch interior diameter at the neck. This is readily and safely done by using a light steel hammer, the powder resting on a table of wood. For convenience of computation, it is advisable to use samples of 100 grams; or, if employing grain weights, of 1543.3 grains. To take the density, weigh out the sample with great accuracy, taking 100 grams, if practicable. The vase being mounted, with the nozzle screwed in place and well immersed in the mercury, close the lower cock, opening both the others, and exhaust the air from the tube and vase. When the gauge shows nearly a perfect vacuum, open the lower cock. The mercury from the dish will then enter and fill the vase, rising in the tube nearly to the barometric height, the vacuum meanwhile being kept up by continuous pumping. As soon as the column becomes stationary, close the lower stop-cock, and re-admit the air to the top of the tube by unscrewing the casing of the vacuum-gauge; close the other cocks and unscrew the nozzle; dismount the vase, jar out the mercury from the tubular spaces outside the cocks, brush the outside clean, and then place the vase on its rest and weigh it. Call this weight of vase and mercury $VM = W$. Empty the vase by opening the cocks, and allow the mercury to return to the dish; also let the mercury run out of the barometer-tube. If the inside of the vase is coated, unscrew both plugs and wipe it out with a cloth; or, if necessary, wash it with aqua regia. With clean mercury, washing is rarely required. In general practice, after having emptied the vase, one plug is unscrewed, and the sample of powder previously weighed out is poured in. The plug being again securely in place, the vase is mounted and the mercury pumped into it, passing up through the powder, filling its interstices, driving out the air, and rising to the same height in the tube as before. When this point is reached, close the cocks, admit the air, unscrew and weigh the vase as before, calling the weight of powder, vase, and mercury $PVM = W'$. From these two weights, together with that of the powder sample, the density is calculated by the proportion: Density of mercury is to density of powder as weight of mercury displaced by powder is to weight of powder; or, if

W = weight of vase and mercury,
W' = weight of powder, vase, and mercury,
w = weight of powder,
D = density of mercury,
d = density of powder,

then $W' - w$ = weight of mercury, vase, and powder, less the weight of powder, and $W - (W' - w)$ = weight of mercury displaced by the powder, and the proportion becomes

$$D : d = W - W' + w : w,$$

or

$$d = \frac{D \times w}{W - W' + w}.$$

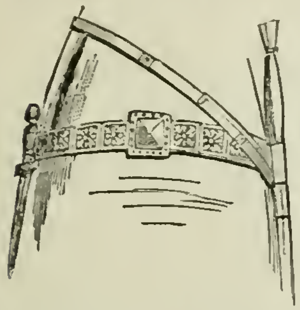
The weight of W should be determined at the beginning and end of each set of trials, and the mean be used to correct the result of the whole series. The mercury used should be of specific gravity $= 13.55055$ at 66° Fahrenheit. Its purity can be tested by comparison with distilled water by the following process: Clean the vase and its connections thoroughly, and weigh it. Call this weight a. Mount the vase and fill it with mercury, and again weigh it, calling the result b. Empty, clean, and connect it again, substituting a dish of distilled water for that of mercury ordinarily used. Fill the vase by pumping slowly to avoid overflowing. Detach and weigh it again, calling this last weight c; then

$$\frac{b - a}{c - a} = D,$$

the density of the mercury, which, if up to the standard, will correspond to that given in the table for the temperature at the time of trial. The mercury used with the densimeter should frequently be strained through chamois-leather to remove impurities which are accidentally introduced into it in experimenting. See *Weighing-machine.*

BALANCE-STEP.—An exercise in squad-drill which is much practiced as a preliminary to marching.

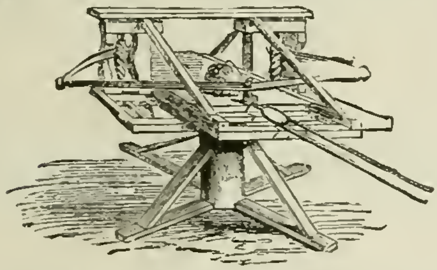
BALDRICK—BAUDRICK.—A band or sash worn partly as a military and partly as a heraldic symbol.



It passes round the waist as a girdle, or passes over the left shoulder, whence it is brought downward obliquely under the right arm, or is suspended from the right shoulder in such a way as to sustain a sword. Many of the effigies of knights contain representations of the baldrick, more frequently as a belt than a shoulder-sash. Queen Victoria frequently wears a blue silken baldrick on state occasions. The name is derived from the *balteus* of the Roman soldier.

BALESTRE.—The *cross-bow à galet*, so called by the Germans, from its being somewhat large in size. Also written *Ballestre.*

BALISTA—BALLISTA.—A large military weapon in use before the invention of gunpowder. The *balista*, the *catapulta*, the *scorpion*, and the *onager* propelled large and heavy missiles, chiefly through the reaction of a tightly-twisted rope of hemp, flax, catgut, sinew, or hair; or else by a violent movement of levers. The scorpion was a kind of large crowbar: the balista threw stones; the catapulta threw heavy darts or arrows, and was somewhat smaller than the balista. One man could manage the scorpion, but two or more were needed for the balista or the catapulta. There was a good deal of mechanism necessary to bring about the propulsive force. The



makers of those machines were very particular in the choice of women's hair, the sinews of a bull's neck, and the tendons of the deer, wherewith to fashion the elastic cord. The onager was a kind of balista, which threw a stone by the agency of a sling instead of a stretched cord. The early chroniclers tell of catapultas that would throw an arrow half a mile, or hurl a javelin across the Danube; and of a balista which threw a stone weighing 360 lbs. Numerous other weapons of an analogous character were known in the Middle Ages—such as the *mangonel;* the *trebuchet*, which threw a large stone by the action of a lever and a sling; the *petrary*, which, as its name implies, threw a stone; the *robinet*, which threw darts as well as stones; the *mate-griffon* and *mate-funda*, both slinging-machines; the *tricolle*, which hurled quarrels, or square-headed arrows; the *espringal* or *springal*, which threw darts; the *ribaudequin*, a large kind of cross-bow; the *war-wolf*, a stone-throwing machine, etc. The arbalest may be regarded as a small portable arrow-throwing balista.

BALISTA FULMINATRIX.—A peculiar war-engine of the Middle Ages. This engine is interesting on account of the men inside the wheels who form its motive power.

BALISTARIUM.—A store-room or arsenal in which the Romans stored their balistas.

BALISTER.—A term applied in ancient times to the cross-bow, carried by the *Balistriers*, or cross-bowmen.

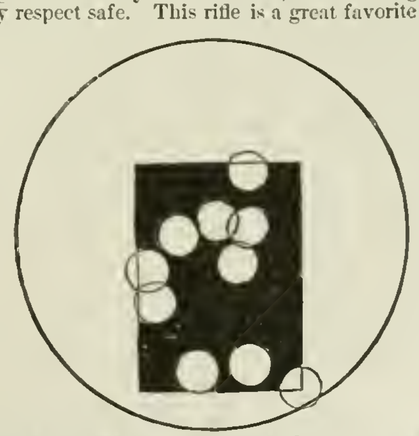
BALISTRARIA.—One of the names given to those narrow apertures so often seen in the walls of old castles, and through which the cross-bowmen discharged their arrows. Balistraria do not seem to have come into use till the thirteenth century. The lower terminations of balistraria are generally circular, sometimes in the form of a shovel. This term, frequently written *ballistraria*, also signified a projecting turret, otherwise called a bartizan, such as is commonly seen in old castles.

BALKS.—Joist-shaped spars, which rest between the cleats upon the saddles of two pontons, to support the chess or flooring.

BALL.—In the somewhat indefinite language of the military and naval arts, all kinds of shot and bullets are occasionally called by the collective name of *ball.* This was especially the case when nearly all such projectiles were solid and spherical, before the era of hollow and spheroidal shells. At present, when the varieties are so numerous, it is more usual to employ the terms *bullet* and *shot.* These, together with *shell*, are subdivided into numerous kinds, the most important of which will be found noticed under their proper designations. A particular class of spherical combustibles is described under *balls.*

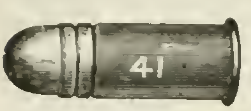
BALL À CULOT.—As no two soldiers would probably use the same number of blows, or the same force, when ramming the ball into the grooves, various degrees of expansion would take place. With a view to expanding the ball regularly and independently of the soldier, a ball with a wedge (culot) was invented. The shape of the cavity in this ball was that of the frustum of a cone, and in this cavity was inserted a piece of iron to act as a wedge. This culot was driven before the powder into the cavity, and by expanding the softer metal of the ball forced it to take the grooves.

BALLARD RIFLE.—An American rifle having a very simple and effective breech mechanism. The extractor is positive and cannot fail to work, as it acts on the same pin with the lever; when the lever is thrown down it withdraws the breech-block, at the same time throwing the hammer to the half-cock notch; after inserting the cartridge, pushing up the lever causes the lock to move forward and upward, closing tightly on the head of the cartridge. There is no possibility of an explosion, as the hammer is at half cock, and there is nothing which might slip through careless handling. Nothing short of firing the gun voluntarily can set it off, thus making it in every respect safe. This rifle is a great favorite with



the Indians of North America, and seems to possess shooting and non-fouling properties not possessed by many other rifles. The Target represented was made after 40 rounds at fifty yards, with this rifle. The wind was from the left rear, light, but the atmosphere was damp, and consequently favorable from the fouling point of view. In no case was there the slightest evidence of any increase of fouling up to 100 shots. The rifle is approved and recommended by the best shots in the leading clubs in the United States, Great Britain, France, and Germany.

BALL-CALIBER.—A ring-gauge for testing the diameter of gun-shot, usually used on board ship.



BALL-CARTRIDGE.—A cartridge for small-arms; the ball and powder being in an envelope or shell. In contradistinction to *blank-cartridge*. See *Cartridge*.

BALLING-FURNACE.—A furnace in which *piles* or *fagots* of iron are heated so as to form balls for rolling. In the *puddling-furnace*, pig-iron is boiled to drive off certain impurities, and the iron therein is formed into balls by the *rabble* or *paddle* of the puddler, so as to be ready for the shingling-hammer or the squeezer which drives the slag from the bloom. At the same heat the iron may be rolled and become a merchantable article of bar-iron; but with some qualities of iron, and for the production of the finer varieties of bar and sheet iron, the bar from the first rolling is cut up by the shears and made into *piles* or *fagots*, which are reheated to form *balls* for re-rolling. The furnace resembles a puddling-furnace, with the exception that it is not designed for stirring and puddling; but the *piles* or *fagots* are laid upon the floor of the reverberating chamber, and are there heated without running together, each being withdrawn as it attains the required condition. The bottom is made up from time to time with sand. It is not a *mere* reheating, but the action of the fire and the admission of regulated quantities of air remove certain impurities which have resisted the previous operations.

BALLING-TOOL.—A tool for aggregating the iron in a puddling-furnace, to fit it for conveyance to the tilt or squeezer.

BALLISTEA.—In antiquity, songs accompanied by dancing, used on occasions of victory.

BALLISTIC MACHINE.—A machine designed to determine by electricity the initial velocity of a projectile. These machines are made in great variety. The Benton velocimeter, devised for use at the Military Academy, and usually known as the West Point ballistic machine, will serve to illustrate their general purpose and construction.

BALLISTIC PENDULUM.—The ballistic pendulum invented by Robins, who is justly held to be the pioneer of modern gunnery, was first used in 1740, with the object of measuring the velocity of projectiles and the resistance of the air. If such a pendulum, being at rest, is struck by a body of known weight, and the vibration which it makes after the blow is known, the velocity of the striking body may thence be determined. The quantity of motion of the body before impact is equal to that of the pendulum and body after impact. It consists essentially of a strong, large pendulum, which has its axis of suspension secured, and a core or block at its lower part. The projectile is fired into this core and remains there, causing the pendulum at the same time to swing through a certain angle α with the vertical; this is measured by a slider which is pushed along a fixed arc.

Before using the pendulum certain adjustments as to symmetry and level are necessary, and it is important to arrange that the pendulum may be struck at such a point that no impulse shall be given to the axis of suspension; in other words, the center of percussion should be hit. It is an established fact that the centers of percussion and oscillation are coincident, and the center of oscillation is readily found by causing the pendulum to vibrate through a small arc; and observing the period (T) taken to perform a number of vibrations (n), then $\frac{T}{n}$ gives the time (t) of a single vibration with considerably accuracy. The length of the corresponding simple pendulum (l), the distance of the center of oscillation or percussion from the axis of suspension, is then known from the formula $t = \pi \sqrt{\frac{l}{g}}$. If the distance of the center of the core from the axis of suspension is exactly equal to l, the instrument is in adjustment; but if this is not the case, weights must be pushed up or down the pendulum by trial and error, till the time of oscillation is found to be correct.

The weight of the pendulum being known, the distance (h) of its center of gravity from the axis of suspension is then found experimentally (if not already determined). A cord, with a known heavy weight at the end of it, is passed over a pulley (in the plane of oscillation), and attached to the lower part of the pendulum, which it pulls through a certain angle β, which is measured. The distance of the point of attachment of the cord from the axis of suspension is also measured; and from these data the position of the center of gravity of the pendulum is easily found.

Let W be the weight of the pendulum in pounds; w, the weight of the projectile in pounds; v, the velocity of the projectile in feet per second; d, the distance of center of percussion from axis in feet; h, the distance of center of gravity from axis in feet; ε, the angular velocity of the pendulum at the instant of impact. Then

$d\varepsilon$ = linear velocity, in feet per second, of the center of percussion at the instant of impact, and

$h\varepsilon$ = linear velocity of center of gravity at the instant of impact.

The projectile is fired into the middle of the core, and the pendulum swings through the angle 2α.

Since the center of oscillation moves as though it were isolated, its velocity $d\varepsilon$ at the instant of impact must be the same as that of a body falling freely under the influence of gravity from the height to which it will rise at the end of its swing, or

$$d^2\varepsilon^2 = 2gd\,(1 - \cos\alpha);$$

whence
$$\varepsilon = 2\,\frac{\sqrt{gd}}{l}\,\sin\frac{\alpha}{2}.$$

As the shot buries itself in the core, rebound is prevented, and we have a case of impact of inelastic bodies, when the momentum of the projectile *before* striking must be equal to that of the pendulum and of the projectile *after* striking, or

$$wv = Wh\varepsilon + wd\varepsilon;$$

whence
$$v = \frac{\varepsilon}{w}\,(Wh + wd).$$

Substituting the value of ε from above, we obtain

$$v = 2\sin\frac{\alpha}{2}\,\frac{Wh + wd}{wd}\,\sqrt{gd}.$$

If the center of percussion is not exactly struck, the velocity of the projectile can still be found by suitable modifications in the calculations; this often had to be done, when firing from a considerable distance, to find the loss of velocity due to the resistance of the air, as it was difficult to hit the exact spot aimed at.

BALLISTICS.—That branch of the science of gunnery which treats of the motion of projectiles. Ancient artillerists considered that the trajectory, or path described by a projectile after it left its piece, was composed of three distinct parts: 1st. The *violent*, which approached a straight line; 2d. The *middle*, or *mixed*, which was a circle; 3d. The last, or *natural*, which was also a right line.

Tartaglia, an Italian engineer, invented the quadrant for measuring elevations, which he divided into twelve parts, and by which he was able to compare the ranges of different cannon, fired under the same or different degrees of elevation. He demonstrated that no portion of the trajectory was a right line, and that the angle which gave the greatest range was 45°.

About 1638, Galileo discovered the laws which

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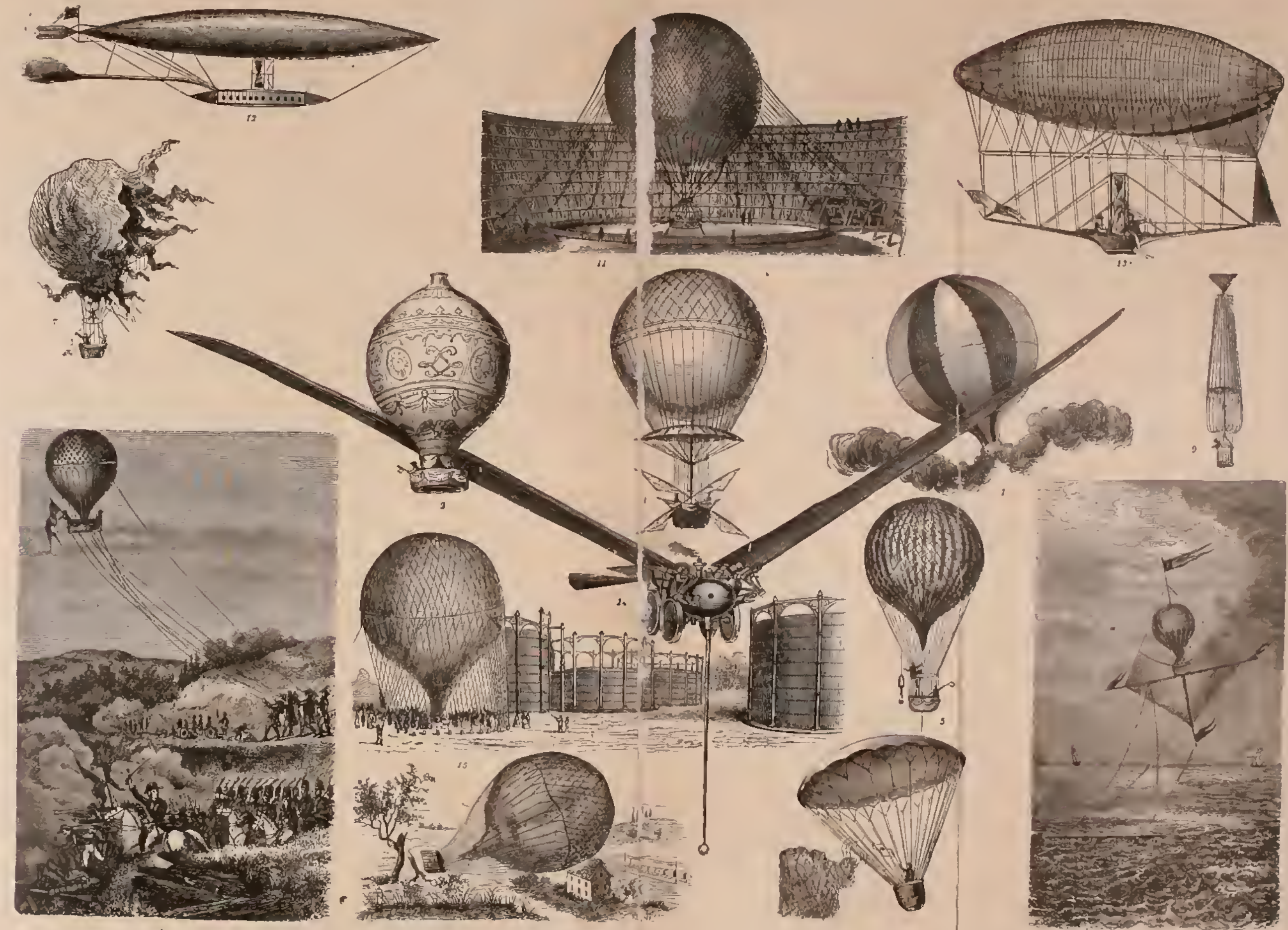


BALLOONS. 1. Montgolfière (first balloon). 2. Pilâtre de Rozier's balloon (first ascent). 3. Blanchard's balloon (first aerial navigation). 4. Coutelle's balloon (first employed in war, at the battle of Fleurus; later first employed for scientific purposes at Hamburg). 5. Green's balloon. 6. Nadar's balloon "Le Géant" (disastrous fall at Hanover). 7. Duruof's balloon "Le Neptun" (exploded). 8. Aeronaut's marine balloon. 9. Parachute closed. 10. Parachute open. 11. "Captive ballon," at London. 12. Rufus Porter's guidable aerial ship. 13. Dupuy de Lôme's guidable aerial ship. 14. Kaufmann's flying machine. 15. Filling a balloon. Gasometers.

II—150.

govern the fall of bodies, and from these he demonstrated that the curve described by a projectile, thrown in a direction oblique to the horizon, is a parabola, the axis of which is vertical. He did not consider that the air offered any material resistance to the motion of artillery projectiles.

About 1723, Newton demonstrated that the curve described by a spherical projectile in the air was far from being a parabola; that the two branches were dissimilar, and that the descending branch would become vertical if sufficiently prolonged. While he considered the resistance of the air proportioned to the square of the velocity, he did not conceal the fact that this was but an approximation to the true relation, which remained to be determined by experiment.

About 1765, Robins invented an instrument for determining the initial velocity of a projectile, called the ballistic pendulum, by which he was able to show that the range in vacuo was much greater than in air. He also discovered that the rotary motion which spherical projectiles generally assume around their centers of gravity will cause them to deviate from their true direction.

Hutton, who lived about the beginning of the present century, improved the ballistic pendulum, and applied it to determine the true law of the resistance of the air, as exemplified in projectiles of small caliber. At Metz, in 1839 and '40, further experiments were made on the resistance of the air to projectiles of large size, moving with high velocities, and the law of variation was determined with great accuracy.

The subject of ballistics presents two fundamental questions: 1st. To determine the initial velocity of a projectile for a known piece and charge of powder. 2d. Knowing the initial velocity and angle of projection, to determine the range, time of flight, remaining velocity, and, in fact, all the circumstances of the projectile's motion.

BALLIUM.—A term used in ancient military art, and probably a corruption of Vallium. In towns, the appellation "ballium" was given to a work fenced with palisades, and sometimes to masonry covering the suburbs; but in castles, it was the space immediately within the outer wall.

BALLOON.—The art of traversing the air by means of balloons, generally called aëronautics, and sometimes aërostation, is of comparatively recent date. The germ of the invention of balloons is to be found in the discovery by Cavendish, in 1766, of the remarkable lightness of hydrogen gas, then called inflammable air. Prof. Black, of Edinburgh, seems to have been the first who conceived the idea that a light envelope, containing this gas, would rise of itself. He requested Dr. Monro, the Professor of Anatomy, to give him some thin animal membrane for the experiment, but for some reason or other it was never made. The first practical attempts were made by Cavallo, who, in 1772, filled swine's bladders and paper bags with the gas, but found the former too heavy and the latter too porous; and he only succeeded in raising soap-bubbles inflated with the gas. The invention of the balloon is due to the two brothers Stephen and Joseph Montgolfier, paper-makers at Annonay, in France, whose names are as distinguished in the development of their own branch of manufacture as in the history of aëronautics. It immediately struck these brothers, on reading Cavendish's *Different Kinds of Air*, that the air could be rendered navigable by inclosing a light gas within a covering of inconsiderable weight. Led by their avocation, they fixed upon paper as the most fitting material for the purpose, and first attempted to make balloons of paper filled with inflammable air. Finding that these emptied themselves almost as soon as they were filled, instead of abandoning the paper as an unsuitable covering for the gas, they sought after another gas more suited to the paper. By a chain of false reasoning which need not here be detailed, they thought they found such in the gas which resulted from the combustion of slightly moistened straw and wool, which had, as they imagined, an upward tendency, not only from its being heated, but from its electrical properties, which caused it to be repelled from the ground. It is hardly necessary to say that this so-called Montgolfier gas possessed no advantages for raising balloons other than that possessed by heated air of any kind; in fact, the abundant smoke with which it was mixed, by adding to its weight, rather detracted from its merits. At Avignon, in November, 1782, Stephen Montgolfier first succeeded in causing a silk parallelopiped, of about 50 cubic feet, to rise to the roof of a room. Encouraged by this success, the brothers made experiments on a larger scale at Annonay with an equally happy result; and finally, in June, 1783, in the presence of the States of Vivarais, and of an immense multitude, they raised a balloon, 35 feet in diameter, to a height of 1500 feet. This last, nearly spherical in shape, was made of packcloth, covered with paper, and was heated by an iron choffer placed beneath it, in which 10 pounds of moist straw and wool were burned.

Balloons are useful in warfare for purposes of reconnoitering, and in the case of a beleagured city, for keeping up communication with the outside world. The Prussians are said to have reconnoitered the French position before Metz in the war of 1870 by means of a balloon with telegraph attached, and it is further said that the survey, made with great care, was most successful, and conveyed instantaneously to General von Moltke the true position of the French army at all points, and its movements. From an account given of the first balloons used for war purposes, it appears that the proposal for employing what were then termed captive balloons was made by the Committee of Public Safety in 1793. After some preliminary experiments at Meudon, a small Corps of Aërostats, skilled in precarious crafts, was formed on the model of an Engineer Company, and dispatched to Manberg, then besieged by the Dutch and Austrian troops. The balloon used was 30 feet in diameter, and rose 1800 feet with two observers and 130 pounds of ballast. It was managed by two ropes attached to the net, and was filled with hydrogen, obtained with much difficulty and expense from water. The immediate moral effect upon the enemy of the use of this balloon by the besieged was extraordinary. They imagined, which was far from being the case, that their every movement was at once made patent to the French, and it was this that in a great measure caused the demoralized Austrians to abandon the siege. The balloon, passing from a defensive to an offensive position, was then transported while inflated to Charleroi, which the French were attacking. Its apparition at once deprived the besieged of all confidence in their strength, and hastened the surrender of the town while still efficient for defense. The balloon was subsequently used at Fleurus, where much is attributed to it; then at Brussels, Liége, Aix-la-Chapelle, on the Rhine, and on the Danube. A Corps of Aërostats accompanied the French army to Egypt, but did nothing, as the apparatus was damaged on the way. In 1800 both corps were suppressed. The Prussians used ballooning against the French in 1812, but the results were not encouraging. At Solferino, one of the brothers Godard ascended in a montgolfier; but he was much too late, and the ascent was all but useless. In the American war, balloons were used from time to time, but were attended with no advantage.

The following are the results of experiments made at Woolwich a few years ago in reference to war or captive balloons, inflated at the Royal Arsenal gas-works. They are thus described in one of the public journals of the day: It has been found that a height of 100 fathoms, at a horizontal distance of 600 fathoms from the enemy, would enable the observers to secure the widest expanse of view. With captive balloons it has been found that they attain stability, and remain like a kite, at rest, when the horizontal resultant of the ascensional force and the tension of the cord are equal to the force of the wind; and this enables a second diversion of science to come in and lend its aid in the time of war. The war-balloon having, by a mathematical rule, taken a stationary position, eight cameras and lenses, spread round the balloon at equal distances, enables a complete view of the surrounding country to be photographed, and subsequently examined at leisure. The inclination and length of the cord to keep the balloon in the same stratum of air was found to be easily calculable, subject to the inequality of gales of wind and their change of direction. The Woolwich balloons were held by two new cords, fastened to the network, and terminating at two different points on the ground, which gave greater stability to the balloon, and provided against one cord snapping or being cut by the enemy's fire. Under the old plan, aëronautic correspondence was carried on by the explorers in the balloon-car being provided with white pasteboard tubes, formed like cartridges open at both ends, to which a bullet was securely fastened. Each piece of intelligence was written in pencil in large characters along the major axis of the paper tube or cartridge, which was immediately dispatched by passing the end of the small cord through it, and it was thus precipitated by the gravitation of the bullet into the hands of the expectant General. This plan has just been abrogated by a third diversion of science being brought to bear in the time of war. By the new system of military telegraphy for field-service, and by means of the wagons at present being placed in store for military service, lines of telegraph can be carried through the air from *terra firma* to a balloon several miles distant. The wire can be paid out as fast as the balloon travels, so that if a captive balloon should break or soar away communication could be kept up with it for six miles, or two or more balloons can be sent.

BALLOTING.—A bounding movement of a spherical projectile in the bore of a cannon.

BALL-PROOF.—Incapable of being penetrated by balls from fire-arms or other engines.

BALL-SCREW.—An implement for extracting bullets from the barrel of a gun in cases where it would be dangerous or impossible to expel them by firing. It is screwed on the end of the ramrod, which, being turned, causes the screw-threaded pointed end of the ball-screw to enter the bullet, which is then withdrawn by pulling the ramrod. Witzleben's ball-screw has two jaws with sharp-edged interior shoulders, constituting a portion of a concave screw-thread, which enters the bullet to prevent it from slipping from the grasp of the jaws.

BALL-TRAIN.—In the foundry, a set of rolls for rolling *puddler's* balls into bars. The word *train* signifies that more than one pair is used, the first being *crushing* rolls, and the second *finishing*. The result of the action of the two is *bar*-iron.

BALOTS.—Sacks or bales of wool, made use of in cases of great emergency, to form parapets or places of arms. They are likewise adapted for the defense of trenches, to cover the workmen in saps, and in all instances where promptitude is required.

BALUSTRADE.—A range of balusters, together with the cornice or coping which they support.

The balustrade is often used as a parapet over bridges, for the roofs of large edifices, etc., or as a mere termination to the structure. It is also used to inclose stairs, altars, balconies, etc. Balustrades are made of stone, metal, or wood. See *Fortification.*

BAMBOO.—A genus of grasses, of which it is the most gigantic; it is well known for its great economical importance. It is found in all tropical climates, and the purposes to which it is applied are so numerous that it would be difficult to point out an object where strength and elasticity being requisite, and lightness no objection, to which the stems are not adapted in the countries where it grows. When ripe and hard, it is converted into bows, arrows, quivers, lance-shafts, poles of palanquins, poles for tents, fire and escalading ladders, and used in the flooring and supports of rustic bridges. In an artillery park in India, wherever the bamboo can be procured, it is made use of in carrying heavy weights, such as ammunition-boxes, shot or shell when carried in slings, and for a variety of other purposes.

BAN.—1. Formerly, a title given to some of the military chiefs who guarded the eastern boundaries of the Hungarian kingdom, and was therefore synonymous with the German *markgraf.* The ban, who was appointed by the Sovereign, but not for life, and whose appointment had to be ratified by the National Diet, had originally very extensive, in fact almost unlimited, powers. In political, judicial, and military affairs he was the supreme authority. Within his own territory he exercised an influence similar to that of the Palatine in Hungary, and only lower than a king. In time of war he headed the troops of his *banat*, and if the campaign occurred within its limits, it was his duty invariably to occupy the post of danger. He led the van to battle, or covered the rear in retreat. For these services he was recompensed partly in ready money and partly by a monopoly of salt. The most important banats were those of Dalmatia, Croatia, Slavonia, Bosnia, Machow, and Szorény, but their boundaries changed so frequently that at the present day it is impossible to ascertain what they originally were. The encroachments of the Turks in the sixteenth century rendered the union of the various banats necessary: and after some time the whole were formed into the double banat of Dalmatia and Croatia. A still more complete unity was subsequently obtained by centralizing the military power. In 1723 the authority of the ban was made entirely subordinate to that of the supreme government of Hungary. After numerous vicissitudes, his powers, rights, and titles were strictly defined during the reign of Maria Theresa. He was then acknowledged to be the third dignitary of the Hungarian kingdom, appointed a member of the Hungarian council of government, and president of the council of the banat, and at the coronation of the Hungarian king went before him, bearing the golden apple, the symbol of sovereignty. Such was the position of the ban until the 4th of March, 1849, when Croatia, Slavonia, and Dalmatia were transformed into Austrian crown-lands, and the ban made wholly independent of Hungary. In 1868 Croatia and Slavonia were reunited with Hungary. One of the Hungarian ministers superintends the affairs of the "Kingdoms of Croatia and Slavonia;" while there is a special local administration for internal affairs. The head of this administration is called the ban.

2. Besides the civil use of the word ban, as a proclamation or prohibition, there was a military application of the term in former days in France. When the feudal barons, who held their estates and honors from the king, were summoned to attend him in the time of war, they were called the *ban*, or the levy first called out; while the tenants, subordinate to these barons, formed the *arrière ban*, or secondary levy.

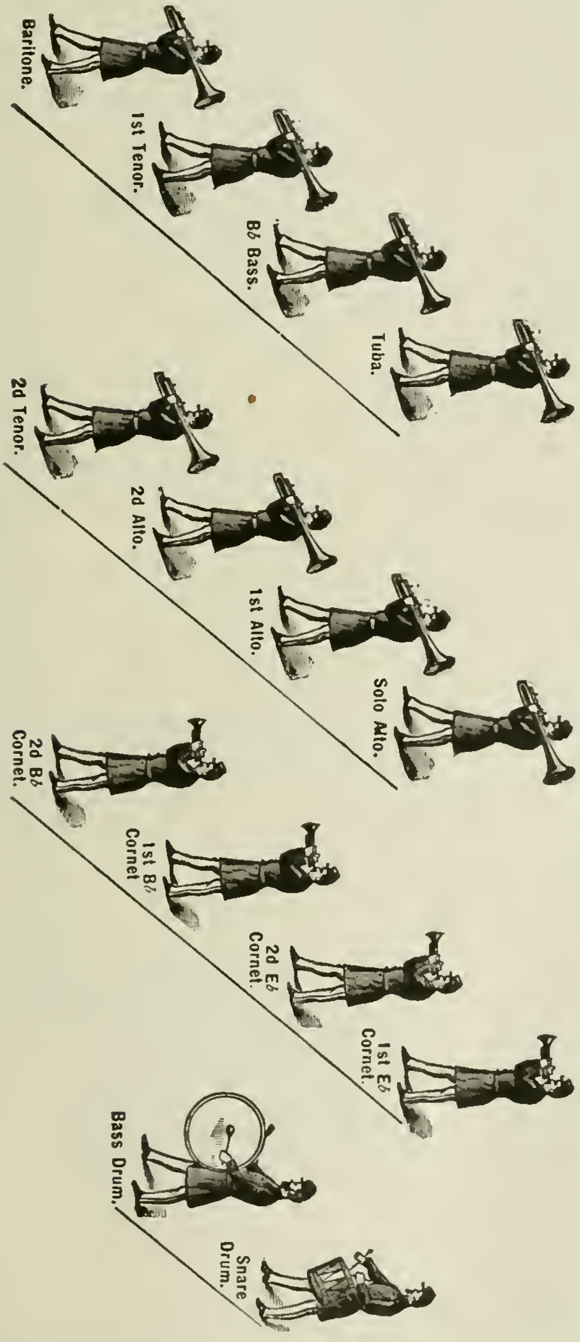
BANCAL.—A curved saber, which was used in France during the Republic and the Empire.

BANCA TIN.—A brand of English tin used to a great extent in gun-construction. The purest comes from the islands of Banca and Billotin, in the Malayan Archipelago, and is sold once or twice a year at Amsterdam and Rotterdam. In Whitney's *Metallic Wealth of the United States*, published in 1854, is given the following analysis of Banca tin:

Tin	99.961
Iron	.019
Lead	.014
Copper	.006
	100.000

English "refined" tin, from the Cornish mines, stands next as regards purity, and is followed by—1st. English tin (which includes "Lamb and Flag"); 2d. Straits tin, from the Malayan Peninsula; 3d. Australian tin.

BAND.—In the United States Army, when it is desired to have bands of music for regiments, there



Band of Fourteen.

are allowed, for each, sixteen privates to act as musicians, in addition to the chief musicians authorized by law, provided the total number of privates in the regiment, including the band, does not exceed the legal standard. Regimental Commanders designate the proportion to be subtracted from each company for a band. The musicians of the band are, for the time being, dropped from company muster-rolls, but they are instructed as soldiers, and liable to serve in the ranks on any occasion. They are mustered in a separate squad under the chief musician, with the Non-commissioned Staff, and are included in the aggregate in all regimental returns. When a regiment occupies several stations, the band is kept at the headquarters, *provided* troops (one or more companies) be serving there. The field-music belonging to companies not stationed at regimental headquarters are not separated from their respective companies. In addition to the regimental bands, there is enlisted in the Army one band, which consists of one Band-leader and not more than twenty-four musicians, ordinarily stationed at the Military Academy.

In the British service, according to military regulations, the only indispensable instruments are drums, fifes, bugles, and trumpets, all of which are employed to give signals on the march or in active service, either for infantry or for cavalry. To supplement this meager musical establishment, however, the officers of regiments organize, chiefly at their own cost, effective military bands, who use a variety of instruments—such as flutes, clarionets, bassoons, horns, ophicleides, big drums, cymbals, triangles, etc. This arrangement has assumed almost the force of a regulation; for officers above the rank of Subaltern are obliged to contribute a sum not exceeding 12 days' pay in the course of a year, and an extra sum when promoted, to the band-fund. The members of these bands are selected from the ranks; but the Band-master, though in uniform, is often a civilian who is hired for the purpose and who generally refuses to accompany the regiment abroad, except at an increased rate of remuneration. The musicians, generally, are in an anomalous position; for, whilst serving in the band, their pay and eventually their pensions are restricted to those of the private soldier. Good musicians have at all times a tendency to quit the band; their better prospects as teachers and players in orchestras and concerts induce them to obtain release by paying the amount of compensation prescribed by regulation. An attempt made by the Duke of Cambridge in 1856 to relieve the Commissioned Officers of part of the expense entailed upon them by the present system failed, except as regards Subalterns, and with that exception matters remained as they were. In most of the regiments of the Line the band consists of a Band-master and about 15 musicians; but in the choice corps the number is often much larger. The band plays on parade and at mess as a part of regular duty.

The success of a military band depends very much on the proper selection of instruments, and the assignment of the most suitable members to the various pieces. The band should have at least fourteen members, as follows: 1st and 2d E*b* Cornets, 1st and 2d B*b* Cornets, 1st and 2d Altos, 1st and 2d Tenor, Baritone, Tuba, B*b* Bass, Solo Alto, Snare Drum, and Bass Drum. When selecting the players for different instruments, let the best musicians take the 1st E♭ Cornet, 1st B♭ Cornet, and Baritone. Next select a large good-natured gentleman for the Tuba, and one with some ability for the 2d B♭ Cornet. The 1st and 2d Altos and 1st and 2d Tenors are about equally difficult. For the Bass Drum have some one who will keep good time, and for the small Drum it is well to have a man who has played before either in a martial or a brass band.

There is some diversity of opinion as to the best modes of holding some of the larger instruments, but it is considered proper and each member is directed to place the mouthpiece in the center of the mouth, after drawing the lips tightly across the teeth; then to relax the lips, leaving the part inside still tight, and to be careful not to push the lips or cheeks out when blowing. To produce high tones, it is necessary to press the instrument firmly against the lips; for low tones, press lightly, and relax the muscles. Begin the tone by pronouncing the syllable *Tu*. To take breath, open the mouth a little at either or both sides of the mouthpiece. The length of the passage to be executed should govern the amount of breath that is taken. If too much breath is taken in short passages, it is likely to produce *suffocation*. It is not advisable to change the position of the mouthpiece upon the lips after it has once been located.

In practicing, members should seat themselves either in a circle or about a long table; the Director at the end, where he may be seen by all. At his right, 2d E♭ Cornet, 1st B♭ Cornet, 2d B♭ Cornet, B♭ Bass, and Tuba. At his left, 1st and 2d Altos, 1st and 2d Tenors, and Baritone. The Drums at the extreme end. Always have the Drums near the Basses, and opposite the Leader. Let it be understood, from the beginning, that when the Conductor raps for attention, every member must obey him, and at once. It would add much interest to the practice if, a few days previously, each of the members would practice privately, getting the proper tones. At first, the exercise will make the lips quite sore, but they will soon become hardened, so that the unpleasantness will pass away. Having decided to attempt new music, the Director should familiarize himself with each part before assigning it, that he may see quickly what is required of every instrument. He should explain the first movement, and after it has been practiced, the harmony horns, consisting of 1st and 2d Altos, Tenors and Basses, should play their parts to the first strain. Then add the lead and other horns. Next play it through with full band. Do this with each strain until the entire number has been played. It is always well to take the water out of a horn as soon as the band stops playing, and then there will be no delays in commencing again.

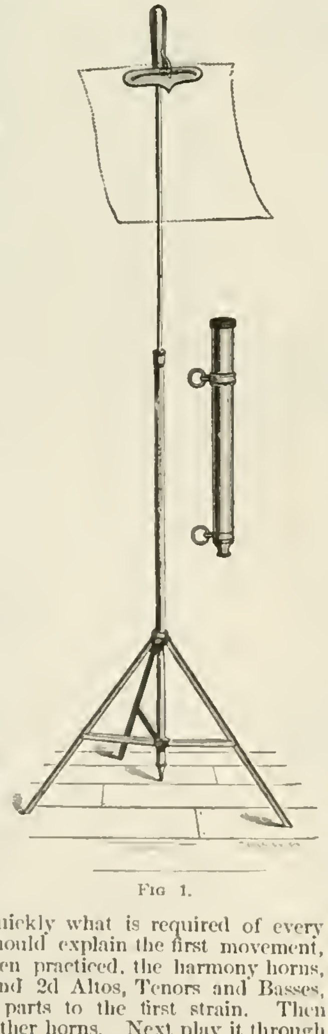


Fig 1.

When requested to play at a funeral, the band should march to a point near the remains, without music. While the body is being removed to the hearse, play something appropriate, *Pleyel's Hymn* or music of this order. After taking a position at the head of the column, funeral marches should be played until arriving at the cemetery entrance, when the band should open order, and cease playing until the procession passes through. At the conclusion of the services the band should resume their position at the head of the column, and immediately play some quick march. It is well to make selections of marches that are not very common, otherwise it would often seem incongruous. All commands should be given in a subdued tone, and the utmost respect and gentlemanly bearing should exist among the band-members.

The smaller Horns, such as E♭ and B♭ Cornets, should be kept in boxes; while the larger ones, such as Altos, Tenors, Baritone, Tuba, etc., should be kept in sacks made of soft flannel. It is well to keep a piece of chamois-skin to wipe each instrument before placing it in its sack or box. Should the valves, in piston-action, refuse to work freely, unscrew the cap, take them out, and wipe them carefully with a soft, dry cloth. Then moisten them slightly and put them back. Spittle, though seemingly vulgar, is the best antidote for a sticky valve. Sometimes it will be necessary to use a little alcohol or kerosene to cleanse them thoroughly. In rotary action, a little alcohol poured in the bell and run through the valves will make them work well. Always keep the slides in order by using a little fine oil several times a year, as the instruments are liable to be blown out of tune, and can be remedied by pulling the slide slightly.

Cornet-players should faithfully and frequently practice all the scales commonly used for the Cornet. It is a great mistake to allow the attention to be given too much, or too soon, to *triple-tonguing*, while simple melodies are neglected. It requires an artist of greater skill and better perception to interpret rightly the less showy class of music than to perform the most difficult strain in triple-tonguing. In the practice of *tonguing*, the syllables *tu, tu, ku*, with C on the staff, should be used. At first this should be done very slowly, while care should be taken to have the *ku* equal in power to the first two syllables. After this is accomplished, other letters on the staff should be used, both above and below C, while at the same time the *tempo* should be increased as much as possible. In the practice of the scales, each note should be commenced as softly as possible, then increased to *ff*, and diminished to *pp*. It is not well to practice immediately after eating. Sleep should be indulged in at regular hours. Total abstinence from stimulants is commendable, as the use of them counteracts the work of hardening the lips.

A want long felt by all bands, for a light and handsome stand that could be carried upon the march, at a serenade, or used in the band-room, has been fully supplied in the "Acme" stand shown in Fig. 1. It might with equal propriety be called the "Sword" stand, having, when not in use, the exact appearance of a handsome sword; and instead of any detraction, materially adds to the appearance of a military band. The drawing shows the stand set up and the extension drawn, ready for use, the dotted lines indicating where the music is placed. The music can be placed at any height from 30 to 60 inches. The holder remains upon the belt when the stand is in use. There are no set-screws to lose, and but one spring in the whole stand, making it simple and very durable. It weighs only 36 ounces, and is entirely nickel-plated, to prevent rusting or tarnishing.

Fig. 2. shows an improved band-lamp, made of brass, hand-spun, and having but one seam. These lamps are three inches deep, burn four hours, use a half-inch round wick with kerosene oil, or, what is better, equal parts of kerosene and lard oil, make a brilliant light, and being balanced in center, keep their equilibrium with the player in any position.

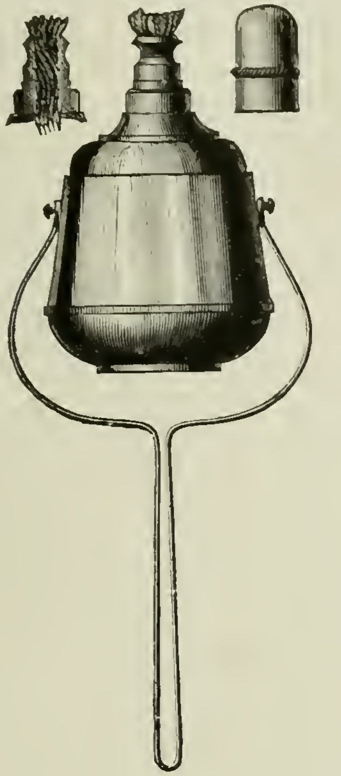


Fig. 2.

Bands will find these a great convenience for night-playing, and much superior to anything else for this purpose. They are readily affixed to the cap, merely taking the place of the pompon or plume, as shown in Fig. 3. The lamp has an improvement, which consists of a tight-fitting tube or cap which, when

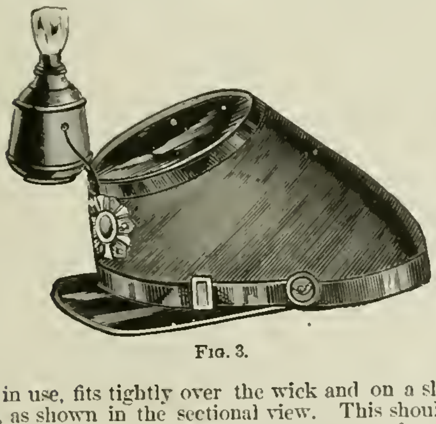


Fig. 3.

not in use, fits tightly over the wick and on a shoulder, as shown in the sectional view. This shoulder, which is made to receive the cap, is set out from the tube slightly, forming a chamber for the oil that escapes from the vent, returning the same back into the lamp. When not in use and the cap on it, it is perfectly air-tight and no oil can escape, which makes them perfectly safe in transporting, while in many lamps no safe provisions are made against the leakage of oil. This lamp is the invention of Messrs. Lyon & Healy, of Chicago, who are the leading importers and manufacturers of band-instruments in the United States, and to whom we are indebted for the many original illustrations of musical instruments throughout the work. See *Drum-major*.

BANDAGES.—Contrivances used by Surgeons, in the field and elsewhere, to apply pressure on a part, or to retain dressings upon wounds. The most common bandage is a strip of linen, calico, or elastic web, from three to five or more inches in breadth, rolled longitudinally; hence the name *roller*. There are also bandages to suit special purposes, as the four-tailed for the head or knee, which consists of a piece of cloth split up on each side towards and nearly to the center. When applied, the tails are crossed and tied so as to make an extemporaneous night-cap. In applying the roller-bandage to a leg, the Surgeon first turns it round the foot, then round the ankle; and so by repeated turns, each one of which should overlap about a third of the previous one, till he reaches the calf of the leg, when he must fold at each turn the bandage sharply back on itself, by which maneuver the bandage will lie flat and smooth on the limb. The operator must remember that the bandage must be applied more tightly at the foot than on the leg, so that it may not impede the course of the blood through the veins. This requires to be practiced, as the effect of a bandage is always for good or evil as it is well or ill applied.

BANDALEER—BANDALIER.—An ancient appendage for facilitating the charging of muskets. It consisted of a broad belt thrown over the left shoulder, serving as a support to the fire-arms, and having suspended from it a dozen boxes (each containing a charge of powder) and a bag for balls. It was both cumbrous and dangerous, and the rattling of the boxes often betrayed the soldier to the enemy.

BANDED-MAIL.—A kind of armor, which consisted of alternate rows of leather or cotton and single chain-mail.

BANDERET.—In military history, *banderet* implies the Commander-in-Chief of the troops of the Canton of Berne, in Switzerland.

BANDEROL.—A small flag used to convey signals from any particular spot to a saluting battery or other post; also, to mark the position to be taken up by the flanks of a regiment at a review in deploying, etc.; also used in marking out a camp. Frequently written *Bandrol* or *Bannerole*.

BANDES.—A common name for bodies of infantry. *Bandes Françaises* was the ancient name of the French infantry; the term, however, became less general, and was confined to the *Prevôt des Bandes*, or the Judge or Provost-marshal that tried the men belonging to the French guards.

BANDIT.—A word originally signifying a "banished" or outlawed person; then one who, because outlawed, wages war against civilized society; and finally a highway-robber. The banditi, or banditti, formed in Italy, in earlier times, as it were a separate community or guild, who submitted to their own stringent laws, carried on both open and secret war with civilized society, and kept up a certain romantic idea of honor. By means of the severe measures which were adopted in 1820 by the Papal Government against the banditti and their abettors, their haunts were broken up. Those who still occasionally disquiet the frontiers of Naples are in general people settled on the spot, who regard robbery and murder as equally a branch of their trade with agriculture. Peter the Calabrian, one of the most famous bandit-chiefs, in 1812 assumed the titles of "Emperor of the Mountains, King of the Woods, and Lord of the Highroads from Florence to Naples." The Government of Ferdinand I. found themselves obliged to conclude treaties with them. The banditti must be distinguished from common robbers, who were called *malviventi*. In later times the banditti were joined by adventurers of all kinds, to such an extent that the Austrian troops who occupied Naples were obliged to make frequent expeditions against them. In Sicily, the banditti are most numerous in the Val Demone. They formerly acquired so much power there that the Prince of Villafranca, as a piece of policy, declared himself their patron, and treated them with much confidence. In the years 1841–43 political fugitives united with robbers and adventurers of all kinds in the Abruzzi, Calabria, and Romagna, and since then they have never been entirely extirpated. The Revolution of 1848–49 added greatly to their numbers, and in several districts of Italy, especially in the States of the Church, between Ferrara and Ancona, they reached an unheard-of degree of boldness, notwithstanding the Austrian army of occupation. Under the command of one Bellino (known by the name of "Il Passatore"), a daring and talented man, who died in 1851, they kept the country in terror, and even burned several villages to the ground. They also carried on a real guerrilla warfare against the military forces of the country. Recent events in Italy have, it is said, recalled numbers of these banditti to a more honorable life. See *Camorra*.

BANDOLEER.—Two centuries ago soldiers' muskets were provided with *matchlocks*, a very slow and ineffective contrivance for firing. The musketeers were furnished with gunpowder in small cylindrical boxes made of wood, tin, or leather, each containing sufficient for one charge. Twelve of these little boxes were fixed to a belt called a *bandoleer*, worn over the left shoulder. See *Bandaleer*.

BAND-SAW MACHINE.—An endless steel belt running over wheels and revolved continuously. It is pliable, so as to conform to the faces of the wheels, and is serrated on one edge. The ends are joined by solder and by neat clamps. Arrangements are made for straining the saw by regulating the relative distances of the wheels; this adjustment also permits the machine to take in saws of different lengths. One advantage of the band-saw over the reciprocating-saw is that there is no lost time in its operation, and no effort required to keep the work to the table, as the action of the saw tends to this result. There is no need of a pump or blower to clear away the sawdust, as it is carried continually downward.

In the English practice the minimum diameter of the band-saw pulley is set at 30 inches; but for wider saws the diameter must be increased. Thus, saws of 2 to 3 inches wide ought not to be worked over pulleys of less than 42 inches in diameter, and for a blade 6 inches wide the pulleys should be 70 to 80 inches.

It will not be uninteresting to give some facts and figures concerning the sawing of lumber by band-saw machinery. A few moments' calculation will serve to convince any one of the great saving in lumber which results from the use of the band instead of the circular saw in working it up. This is quite a consideration, and should be duly appreciated. The scarcity of timber in some parts of our country, and the great value of foreign woods, requires that there should be the least possible loss in its sawing. The saving which results from the use of the band-saw can easily be demonstrated.

If we take a log 30 inches square and 20 feet long, and by calculation cut it up first with a circular saw, then with a band-saw, the result will be found about as follows: The log contains 1500 feet of lumber. Cut with circular saw, $\frac{5}{16}$-inch kerf, into 1-inch boards, we have twenty-three 1-inch boards, 1150 feet; balance kerf, 350 feet—total, 1500 feet. Now cut with band-saw, $\frac{1}{12}$-inch kerf, into 1-inch boards, we have twenty-seven 1-inch boards, 1350 feet; one $\frac{3}{4}$-inch board, 37½ feet; balance kerf, 112½ feet—total, 1500 feet.

It will be noticed that with the circular saw 23 per cent of the log is kerf, and that with the band-saw only 7 per cent. That is, by using the band-saw we have saved 237½ feet of lumber. See *Bevel Band-saw Machine*, *Circular Saw*, *Re-sawing Band-saw Machine*, and *Swing-saw*.

BANISHMENT.—Excepting in the penal sense of transportation, with which it is popularly synonymous, can only now be said to have a legal meaning historically. Formerly, in England, parties who were required to *abjure the realm*—that is, renounce and depart from the country—were, so to speak, *banished;* but the word appears to have a more technical and precise significance in the Scotch law than in the English, and in Scotch law-books is defined as the punishment of exile from Scotland inflicted on persons convicted of certain offenses for which that punishment is provided. But, as a punishment it has either been abolished in that country by express enactment or become obsolete by disuse.

BANNER.—A piece of cloth attached to a pole and usually bearing some warlike or heraldic device or national emblem. In this sense banner is a generic term, including many species, such as standard, ensign, pennon, flag, etc. Banners have been used from the earliest times and in all countries for the purpose of directing the movements of troops. We read of them constantly in the Old Testament, as in Numbers ii. 2: "Every man of the children of Israel shall camp by his standard, and under the ensign of his father's house." The earliest Roman standard was a bundle of straw fixed to the top of a spear. This was succeeded by figures of animals—the horse, the boar, etc.—all of which soon gave place to the eagle, which continued all along to be the chief Roman ensign, and was afterwards assumed by the German and latterly by the French emperors of the Napoleonic dynasty. In addition to the eagle each Roman cohort had a banner, generally a serpent or dragon woven on a square piece of cloth. The standard of the cavalry was a square piece of cloth expanded on a cross, and it was to this that the term *vexillum* properly applied. Examples of these standards are sculptured on the Arch of Constantine at Rome. The top of the staff was also frequently adorned with a figure of Mars or of Victory, and in later times with the head of the reigning Emperor. After Constantine embraced Christianity, the cross was substituted for the head of the Emperor on the purple banner of Byzantium. Standards were less in use amongst the Greeks than has been usual with warlike nations; but a standard, and sometimes a scarlet flag, was employed as a signal for giving battle. On the rise of chivalry in the Middle Ages, the ordering of banners, like every other branch of military organization, attained to something like scientific exactitude. From the banner-royal, which bore the national emblems, to the small streamer attached to the lance, with its cross or stripes, there was a regular subordination, each emblem having its place and its meaning. The pennon of the simple knight differed from the square banner of the banneret, it being pointed at the ends. In addition to their varieties in size, shape, and color, these banners were distinguished by the emblems which they bore. One of the earliest is the Danish raven, depicted on the standard taken by Alfred, of which Asser mentions the tradition that "in every battle, wherever that flag went before them, if they (the Danes) were to gain a victory, a live crow would appear flying on the middle of the flag; but if they were doomed to be defeated, it would hang down motionless." Nor did the privilege of carrying banners belong to princes and knights alone; bishops and abbots displayed similar ensigns, which were carried before them in religious processions and under which their retainers fought in their defense. It was to these that the term "gonfalon," a word as to the origin of which much diversity of opinion exists, was more commonly applied. In place of the heraldic emblems of the knight, the banner of the Church and of towns and communes usually bore the effigies of saints. Some banners, however, displayed no ensigns whatever and were known simply by their color. Of this the *oriflamme*, or plain ruddy flag of St. Denis, was a famous example. The celebrated Bayeux tapestry throws considerable light on banners, as well as on other matters connected with the warlike arrangements of the Middle Ages. By every warlike people the banner has been regarded as the emblem of national honor, as a palladium for the defense of which the individual warrior was at all times ready to sacrifice his life. From the converse of this feeling, banners and flags taken from the enemy have always been regarded as special trophies of victory, and places of honor in churches and public buildings have consequently been assigned them. See *Colors*, *Flags*, and *Standard*.

BANNERET.—A higher grade of knighthood conferred by the Sovereign for some heroic act performed in the field, and so called because the pennon of the knight was then exchanged for the banner—a proceeding which was effected by the very simple means of rending the points from the pennon. The first Banneret in England is said by Froissart to have been made by King Edward I., and the last time the honor was conferred was by Charles I. after the battle of Edgehill, the recipient being an individual who rejoiced in the familiar name of John Smith. The ceremony of the creation of a Knight-banneret must have been very impressive to persons filled with the ideas which were prevalent in the Ages of Chivalry. The King or his General, at the head of his army, drawn up in order of battle after a victory under the royal banner displayed, attended by all the Officers and Nobility of the Court, received the Banneret-elect, who was not necessarily a knight previously, led between two knights of note or other men famous in arms, carrying his pennon in his hand, the heralds walking before him and proclaiming his valiant achievements, for which he deserved to be made a Knight-banneret, and to display his banner in the field. The King, or General, then said to him, "Advance, Banneret!" (*advances toy bannerel*), and caused the point of his pennon to be torn off. The new knight, with the trumpeters sounding before him and the Nobility and Officers bearing him company, was sent back to his tent, where a noble entertainment was provided by the King. Some attempts have been made to revive the title in recent times, as when George III., at a review of the navy at Portsmouth in 1773, conferred it on Admiral Pye and several other officers.

BANQUETTE.—In fortification, a device by which the men are able to deliver their fire over the parapet. It is made just high enough above the terre-plein to allow men of medium stature to fire over the interior crest. The distance of the tread below the crest is taken, for this purpose, at four feet and six inches; sometimes it is taken three inches less, or four feet and a quarter. The width of the tread depends upon the number of ranks expected to occupy it. In the days of smooth-bores and muzzle-loading muskets it was made wide enough for two ranks. It is rarely occupied, at the present time, by more than one rank. A width of two feet is sufficient for one rank, although it is usually made *three* feet wide in ordinary field-fortifications. The tread is made with a slope to the rear, to allow the water falling on it to drain off. It is connected with the terre-plein either by a slope or by steps. The inclination of the former is usually $\frac{1}{2}$; it may be greater if the banquette is low. When steps are used, the tread of each step should not be less than twelve nor more than eighteen inches; the rise should not be less than nine nor more than twelve inches. Steps are generally used whenever it is a matter of importance to gain space. All other things being equal, the ramp or inclined slope is preferred to steps. See *Field-fortification*.

BANQUETTE SLOPE.—In fortification, a slope of earth or timber placed in rear of the banquette when the top cannot be reached by an ordinary step.

BAPTISM OF BLOOD.—The act of being baptized with blood, and used specially with reference to soldiers who fought on their first battle-field. In the old French service, the *baptism of blood* equalized all grades; and military services, not rank, were the recognized claims for promotion.

BAPTISM OF FIRE.—A figurative term applied to soldiers who have passed through their first fire in battle.

BAR.—1. In Heraldry, one of those more important figures or charges which are known as *ordinaries*. By heralds, the ordinaries, or as, by way of eminence,

they are called, the "honorable ordinaries," are commonly reckoned as ten in number, the subordinaries, or minor charges, being greatly more numerous. The bar, like the fess, is formed by two horizontal lines passing over the shield, but it differs from it in size, the fess occupying a third, the bar only a fifth part, of the shield. There is this further difference between these two ordinaries, that the fess is confined to the center, while the bar may be borne in several parts of the shield. There is a diminutive of the bar, called the closet, which is half a bar; and again of the closet, called the barrulet, which is half a closet, or the fourth part of a bar.—BAR-GEMEL is a double bar, from the French terms *jumeau*, *jumelle*, a twin. Also written *barr*.

2. An elongated piece of wood, metal, or other solid substance. In the iron-manufacture, bar is a rod, either round or square shafted. The round ones are made by drawing the iron red-hot through a bore or hole in a plate, and the square ones by passing it likewise red-hot through a roller-mill between two rollers counter-grooved, with their triangular-grooved faces forming the square opening for the passage of the iron. Railway and knee iron is made in the same manner. Bars have various denominations in the construction of artillery-carriages, etc., as sweep-bars and cross-bars for tumbrils; fore, hind, and under cross-bars for powder-carts; shaft-bars for wagons; and dowel-bars, used in mortar-beds.

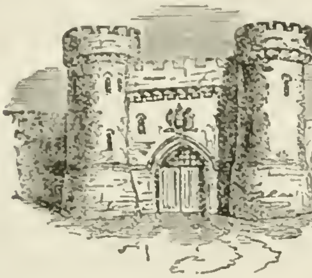
3. In hydrography, a bar is a bank opposite the mouth of a river, which obstructs or *bars* the entrance of vessels. The bar is formed where the rush of the stream is arrested by the water of the sea, as the mud and sand suspended in the river-water are thus allowed to be deposited. It is thus that deltas are formed at the mouths of rivers. The navigation of many streams (as the Danube) is kept open only by constant dredging or other artificial means.

4. In law, the word has several meanings; thus, it is the term used to signify an inclosure or fixed place in a Court of Justice where lawyers may plead, or, perhaps more correctly, where they can address their advocacy on behalf of their clients. A veiled-off space within the Houses of Parliament is similarly called the bar. The dock, or inclosed space where persons accused of felonies and other offenses stand or sit during their trial, is also called the bar; hence the expression "prisoner at the bar." This word has also a general meaning in legal procedure, signifying something by way of stoppage or prevention. There is also a *trial at bar;* that is, a trial before the judges of a particular court, who sit together for that purpose *in banc*.

BARB.—1. The reflected points of the head of an arrow; also, the armor for horses.

2. The designation of a noble breed of horses cultivated by the Moors of Barbary, and introduced by them into Spain. Barbs are less remarkable for their beauty and symmetry than for their speed, endurance, abstinence, and gentle temper.

BARBACAN—BARBICAN.—A projecting watch-tower, or other advanced-work, before the gate of a castle or fortified town. The term barbacan was more specially applied to the outwork intended to defend the drawbridge, which in modern fortifications is called the *tête du pont.* "To begin from without, the first member of an ancient castle was



Barbacan.

the barbacan, a watch-tower for the purpose of descrying an enemy at a greater distance" (Grose's *Antiquities of England and Wales*); and, to the same effect, Camden, speaking of Bedford Castle, says it was taken by four assaults: in the first was taken the barbacan; in the second, the *outer* balia. (See also Parker's *Glossary of Architecture.*) There are a few perfect barbacans remaining in England, as at Alnwick and Warwick; but the best examples of it, as of the other parts of the fortification of the Middle Ages, are probably to be seen in the town of Carcassone. A very curious and minute account of the siege of Carcassone in 1240, in the form of a report to Queen Blanche by the Seneschal who defended it, preserved in the archives of France, has been published in Hewitt's *Ancient Armor*, in which the uses of the barbacan are fully illustrated. The street called Barbican in London, near Aldersgate Street, marks the site of such a work, in front of one of the gates of the old city.

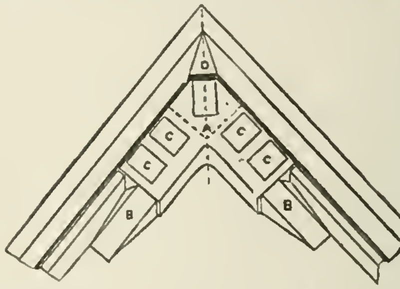
BARBED AND CRESTED.—An heraldic term by which the comb and gills of a cock are designated, when it is necessary to particularize them as being of a different tincture from the body. The common English term is *wattled and combed*, gules, or whatever else the tincture may be.

BARBETS.—Peasants of Piedmont who abandoned their dwellings when an enemy had taken possession of them. They formed into bodies and defended the Alps.

BARBETTE.—The barbette is a construction by means of which a piece can fire over a parapet. It consists of a mound of earth thrown up against the interior slope; the upper surface of which is level, and two feet nine inches below the interior crest for guns of small caliber, and four feet for heavy guns. If the barbette is raised behind a face, its length should be sufficient to allow sixteen and a half to eighteen feet along the interior crest for each gun; and its *depth*, or the perpendicular distance from the foot of the interior slope to the rear, should be twenty-four feet, for the service of the guns. The earth of the barbette at the rear and sides receives the natural slope. To ascend the barbette, a construction termed a *ramp* is made; this is an inclined plane of earth, which connects the top of the barbette with the terre-plein. The ramp is ten feet wide at top, and its slope is six base to one perpendicular. The earth at the sides receives the natural slope. The ramp should be at some convenient point in the rear, and take up as little room as possible.

As barbettes are usually placed in the salients, an arrangement is made for the guns to fire in the direction of the capital. A pan-coupée of eleven feet is first made; from the foot of the interior slope at the pan-coupée, a distance of twenty-four feet is set off along the capital; at the extremity of this line a perpendicular is drawn to the capital; and five feet are set off on this perpendicular on each side of the capital; from each of these points, on the perpendicular, a line is drawn perpendicular to each face respectively; the hexagonal figure thus laid out is the surface of the barbette for one gun. The ramp in this case is made along the capital.

If three or more guns are placed in the salient, a pan-coupée is formed as in the last case; and twenty-four feet are in like manner set off on the capital; but instead of proceeding as in the last case,



Barbette, with Pan-coupée.

a perpendicular is drawn from this point to each face, as shown in the drawing, and the pentagonal space thus inclosed will be taken for the gun in the salient; from the perpendiculars last set off as many times sixteen and a half feet will be set off, on the interior crest of each face, as there are guns required: this will give the length of the barbette along each face; the depth will be made twenty-four feet, and the two will be united in the salient. One or more ramps may be made as most convenient.

To give temporary cover to guns on a field of battle and enable them to command a wide field of fire, a parapet of just sufficient height to allow the guns to fire over it may be thrown up for the purpose, the earth being taken from a ditch in front. The ground may be roughly leveled off far enough to the rear for the maneuver of the guns. Between each gun a shallow trench may be dug parallel to the wheels, where the gunners can find shelter when not serving their pieces.

The advantages of the barbette consist in the commanding position given to the guns, and in a very wide field of fire; on these accounts the salients are the best positions for them. Their defects are that they expose the guns and men to the enemy's artillery and sharp-shooters. Light guns, particularly howitzers, are the best for arming barbettes, because the hollow projectile of the latter is very formidable both to the enemy's columns and to his cavalry, and when his batteries are opened against the salients the light pieces can be readily withdrawn.

BARBETTE CARRIAGE.—A carriage of the stationary class, on which a gun is mounted to fire over a parapet. A barbette gun is any gun mounted on a barbette carriage.

BARBETTE FIRE.—Barbette fire can only be obtained by some arrangement which raises the gun into a position from which it can be fired over the parapet. There are two methods by which this can be done: *one*, by mounting the gun on a high carriage, or on a carriage which admits of the gun being raised to the necessary position; *the other*, by building a mound of earth sufficiently high behind the parapet, and placing the gun on this mound. The latter is the method generally employed in field-works. The artillery used in the defense of field-works may be either siege or field guns; but most generally the latter are employed. The upper surface of the platform on which the wheels rest, or the upper surface of the barbette when no platform is used, should be at a distance below the interior crest just sufficient to allow the gun to fire over the interior crest and parallel to the superior slope. A distance greater than this would interfere with the efficiency of the gun; a distance less would unnecessarily expose the gun and carriage to the enemy's fire. The axis of the trunnions of a field-gun, in the United States service, is about forty-three inches above the ground on which the wheels rest. The diameter of the piece at the muzzle and the inclination of the superior slope being given, it is easy to determine what should be the distance of the upper surface of the barbette below the interior crest. The general rule used is to take this distance at two feet and nine inches for field-guns, and four feet for siege-guns, when mounted upon the ordinary carriages.

BARBOLE.—A heavy battle-axe used in ancient times; now obsolete.

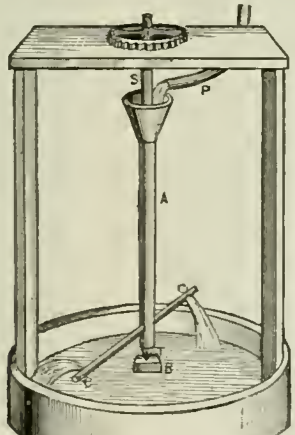
BARCE.—A small gun, shorter and thicker than a falconet, which was formerly used on board ship. Also written *Berche*.

BARDINGS.—Such parts of horse-armor as protect the animal's head, neck, and rump: the *champ-front*, the *manifaire*, the *poitrel*, and the *croupier*. Also written *Bard*.

BARIL ARDENT.—A barrel filled with layers of tarred chips intermixed with powder, and primed at each end with a shell-fuse. It was formerly used for illuminating purposes, and had holes bored in it for the purpose of admitting air to the burning contents.

BARIL FOUDROYANT.—A contrivance of the same nature as the *baril ardent*, with the addition of grenades placed between the layers of chips. These were used at the defense of a breech, by rolling them upon the assailants. Also written *Baril d'artifice*.

BARKER'S MILL.—A water-wheel invented by Dr. Barker towards the end of the seventeenth century. It is represented in its simplest or typical form in the drawing. A is a wide metal pipe, resting at



its lower end, by the steel spindle T, on a metal block B, and kept in a vertical position by the spindle S at its upper end, which passes through the frame of the machine, so that it can easily revolve round its axis. Near its lower end two smaller pipes or arms, C, C, are inserted, which project horizontally from it, and these have each, at the outer extremity, a hole cut vertically in them, opening towards opposite sides. The water is supplied by the pipe P, which opens over a funnel-like widening on the upper part of A, and the quantity is so regulated that while the pipe A is kept nearly full, no more is admitted than issues from the lower orifices. The reaction caused by the water gushing from the arms forces them backwards, and gives to the whole machine a rotary motion. This reaction is much the same as is seen in the recoil of a gun when fired, or in the pushing back of a small boat by the foot on stepping ashore. It may be also thus explained: Suppose that the arms were closed all round, the water would press against the sides with a force proportional to the height of the water in the pipe A, and the pressure against any particular surface of the side would produce no motion of the arm, because an equal pressure is exerted in a contrary direction by a corresponding surface opposite to it. Now, if one of these surfaces be cut out, the pressure against the other, being uncounteracted, forces the arm in the opposite direction to that of the side in which the hole is made. This being done to both arms on opposite sides, two equal pressures are produced, which conspire in generating the same motion of rotation. As soon as motion ensues, centrifugal force comes into play, which, throwing the water out towards the ends of the arms, increases the rapidity of its discharge, and also its reacting power. When the wheel is in action, the water thus acts under the influence of two forces—one being the pressure of the column in A, and the other the centrifugal force generated by the rotation of the wheel itself. The motion of the wheel is transmitted, by the spur-wheel fixed to the spindle S, to the machinery which is to be driven by it.

The power is manifestly increased by heightening the water-column, or by lengthening the arms—the former increasing the pressure of the water, and the latter increasing the leverage at which this pressure acts. In the mill shown in the figure, the column in A cannot be advantageously heightened, for the higher it rises the greater must be the weight which the conical spindle, T, has to sustain, and the greater, consequently, becomes the friction. It is from this circumstance that such mills are found, in practice, to yield but a small mechanical effect—the friction consuming too large a proportion of the work of the wheel. Hence, in the reaction-wheels now in use, the original Barker's mill has been so modified as to allow of the water being conducted from the reservoir below the arms instead of above. This is effected by making the vertical pipe revolve below in a stuffing-box at its junction with the conduit, and above by a pivot moving in the fixed frame. By this arrangement the friction attending the rotation is reduced to a minimum, for not only is the weight of the water placed out of account, but also a large proportion of the weight of the wheel itself, which is borne by the upward pressure of the water. The mechanical performance of such wheels is said to be highly satisfactory, producing, with a limited supply of water falling from a considerable height, a useful effect hardly to be obtained by any other contrivance. The power of these machines may be also increased by using curved instead of straight arms. With straight arms a considerable loss of force is incurred by the sudden change of the direction of the current when it leaves the arm, which does not take place to the same extent with curved arms, where this change is effected gradually. In Whitelaw's mill (hence called the Scottish turbine), the form of Barker's mill generally met with in Scotland, there are three instead of two curved arms of this description. Considerable difference of opinion still exists as to the merits of Barker's mill, some considering it as the most perfect way of applying water-power, and others putting it in the same rank as an undershot-wheel, with the same water-supply. Of late years it has been more extensively employed than formerly.

BARNACLES.—1. In Heraldry, barnacles resembled what are now called twitchers, instruments used by farriers to curb and command unruly horses. Barnacles are frequently introduced into coats of arms as a charge.—2. A noose attached to a stock or handle, and nipped around the upper lip of a horse. It is twisted so as to be somewhat painful, in order to give the command of the head to the person holding the same. It enables a trooper to hold the horse's head aloft to keep him from biting, occupy his attention, and measurably prevent his kicking.

BARNEKOV-GREENE GUN.—A breech-loading rifle having a fixed chamber closed by a movable breech-block, which slides in the line of the barrel by indirect action, being moved by levers from above. Its distinguishing characteristic is a short sliding block, back of which is a pair of links, secured at their forward end to the block, and in rear to the frame. The rearmost one of them contains the hammer, in cocking which the combination is bent upward and so withdraws the block. The cartridge-shells, when extracted, drop through a hole left for the purpose in the frame.

BAROMETER.—If a straight tube 32 or 33 inches long and closed at one end is filled with mercury and, the open end being stopped with the finger, immersed in a vessel filled with the same substance and the finger removed, the fluid will stand at about 30 inches above the level of the mercury in the vessel. The column of mercury in the tube is supported by the pressure of the atmosphere upon the surface of the mercury in the cup, and it is therefore assumed that the weight of a column of mercury of uniform diameter, 30 inches high, is equal to the weight of a column of air of the same base, extending to the top of the atmosphere. This is the barometer invented by Torricelli in 1643 and still used in essentially its original form. As every fluctuation of atmospheric pressure is faithfully shown by the varying height of the fluid in the Torricellian tube, the instrument is, as its name implies, a measure of the weight of the atmosphere. The barometer as usually made consists of a glass tube about 34 inches long, closed at one end, filled with mercury, and placed in a vertical position with the open end immersed in the mercury, contained in a cup called a cistern. A scale of inches and tenths, placed at the top of the column, enables the height of the mercury to be read, and in the higher grade barometers a vernier facilitates the reading of the scale to hundredths. A thermometer is usually attached, so placed that its temperature shall be the same as that of the barometer column, by which the correction for temperature may be accurately made. The tube should not be too small; to allow freedom of motion to the column it should have an internal diameter of from one-third to one-half inch. The mercury must be absolutely pure, freed from moisture, and of the specific gravity of 13.594. Extreme care is necessary in excluding from the tube both air and moisture, the pressure of which filling the tube above the mercury and exerting a pressure upon the upper surface of the column, would depress it below the proper height. The tube should be absolutely clean, and the mercury should be filtered, and both should be heated in order to expel moisture. A small portion of mercury being carefully introduced into the tube, it is held over a charcoal-fire until the mercury boils, the tube being held in an inclined position so that any air-bells may readily escape. More mercury is added and the process of boiling repeated until the tube is filled. When a barometer-tube has been carefully filled and properly freed from air and moisture, the mercury will, when the tube is reversed, strike the top of the tube with a sharp metallic sound. The barometer tubes are usually attached to wood frames, of which there is an infinite variety in design and cost, but in standard barometers for strictly scientific purposes a cylindrical brass frame is used, the index of expansion of that metal being more nearly the same as that of glass. As now arranged, with adjusting screw below the cistern, the mercury can be forced up into the tube and the barometer rendered perfectly portable. It has been stated that the height of the column above the level of the mercury in the cistern indicates the weight of the atmosphere. It is obvious, however, that the level of the mercury in the cistern must vary with the amount of mercury which the varying atmospheric pressure causes to enter or leave the tube. To compensate for this difference of level of the mercury in the cistern, various forms of barometer have been devised, the principal of which are that on Fortin's principle, the Kew barometer, and the siphon, or Gay-Lussac, barometer. In Fortin's barometer, Fig. 1, a straight tube enters a cistern, the upper part of which is glass, while the lower part is of flexible leather under which is a lifting-screw. The lower extremity of a small ivory point, pointing downwards, denotes the zero-point of the scale, which is in true inches. At every observation the surface of the mercury in the cistern is exactly adjusted by the lifting-

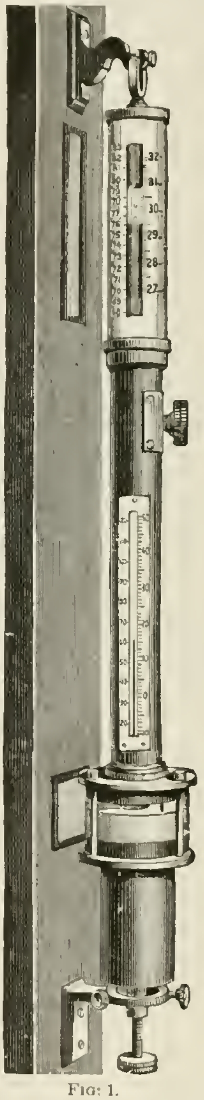


Fig. 1.

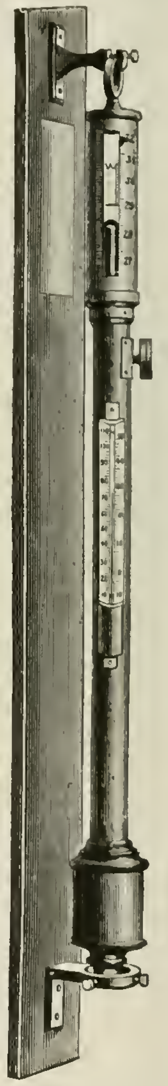


Fig. 2.

screw to the level of the ivory point. This lifting-screw and flexible cistern bottom serve the purpose, also, of making the barometer portable by confining the mercury in the tube and preventing that pumping of the fluid which in transit is apt to endanger the instrument. The Fortin barometer can only get out of order by the admission of air or moisture, and it is not affected by changes in the material of the cistern or of the fluid itself. It is therefore well adapted for scientific purposes, and the higher grade of standard barometers are usually made on this principle. The Kew barometer, Fig. 2, was originally recommended to the Government by the Kew Committee of the British Association, as a form of barometer well adapted for marine observations, and was adopted by the British Government for that purpose. It has been found equally well suited to land and marine service, and is in extensive use in meteorological stations. In this form of barometer the cistern is closed and is composed of iron or wood. Cisterns of wood are sufficiently pervious to permit of the mercury being affected by the variations of atmospheric pressure. Those made of iron have a small aperture at the top, which is closed by a piece of leather. Sufficient mercury is contained in the cistern to cover the end of the tube in whatever position the instrument may be placed. To compensate for variations in the level of the mercury in the cistern the scale is shortened from above downward in proportion to the relative size of the diameter of the tube and of the cistern. For use at sea the tube of this barometer is contracted to prevent oscillation during the heaviest storms. In the siphon barometer the open end of the tube is bent upward in the shape of a siphon, the short limb being from six to eight inches long. The pressure of the atmosphere upon the surface of the mercury in the short limb sustains the column of mercury in the long limb, the fluid in the short limb falling with its rise in the tube and rising with its fall. The upper part of the tube is made of equal diameter with that of the lower limb, so that the distance between the upper and lower levels of the mercury is always the height of the barometric column. A scale of inches, starting from a zero-point, taken near the bend of the tube, with verniers fitted to each limb, gives the means of measuring the long and short columns. The difference of the two readings is the height of the barometer. By another method the zero-point is taken at some intermediate position, and the distances of the mercury-levels upward and downward from this measured, their sum being the height of the barometer. With this barometer no correction for capillarity is required, the capillary action of the glass being considered the same at each of the mercury surfaces. The barometer-scale being divided into inches and tenths, the vernier enables us to subdivide the tenths to hundredths and thousandths of an inch. Fig. 3 shows the scale of a standard barometer divided into half-tenths, or .05, of an inch, as A B. The vernier D is made equal in length to twenty-four of these divisions, and is divided into twenty-five equal parts; one space on the scale is larger, therefore, than one on the vernier by the one twenty-fifth part of .05, which is .002 inch, so that the vernier shows differences of .002. The vernier reading upwards, the lower edge, D, indicates the top of the mercurial column and is the zero of the vernier-scale. In the drawing, the zero being exactly in line with $29\frac{5}{10}$ inches of the fixed scale, the barometer reading would be 29.500 inches. The figures 1, 2, 3, 4, and 5 on the vernier measure hundredths, and the intermediate lines thousandths, of an inch. In Fig. 3 the zero of the vernier is between 29.65 and 29.70 on the scale. Looking up the vernier and scale, the second line above 3 is perceived to lie evenly with a line of the scale. This gives .03 and .004 to add to 29.65, so that the actual reading is 29.684 inches. For the ordinary purposes of the barometer such minute measurement is not required. In household and marine barometers the scale is only divided to tenths and the vernier constructed to measure hundredths of an inch. This is accomplished by making the vernier either nine or eleven tenths of an inch long and dividing it into ten equal parts. To take a reading, place a piece of white paper behind the tube to reflect the light and aid in setting the vernier accurately. Adjust the surface of the mercury in the cistern carefully to the ivory point or zero of the scale. To determine the contact it will be found best to slightly immerse the point in the mercury first and then slowly lower the screw until the depression caused by this immersion disappears. Tap the barometer with the hand to free the mercury from the sides of the tube. Sufficient force should be used to agitate the top of the column. Bring the lower edge of the vernier exactly on a level with the top of the mercurial column. When set properly, the front edge of the vernier, the top of the mercury, and the back edge of the vernier should be in the line of sight, which line will thus just touch the middle and uppermost point of the column. Care must be taken to read with the eye exactly on a level with the top of the mercury. The inches and tenths may then be read from the scale, and the hundredths and thousandths from the vernier. A reading of the attached thermometer should also be taken. All readings of the barometer are subject to corrections, in order to eliminate various sources of error and to harmonize the indications of different instruments, so that the observations can be used for scientific purposes. These corrections are for index error, capacity, capillarity, temperature, altitude above sea-level. It is necessary to find the index error of each instrument by comparison with a standard instrument whose constant of error is known. This being determined, is a fixed quantity to be added or subtracted from each observation. In all barometers on the Fortin principle, the correction for capacity is made by the lifting-screw. The Kew barometer requires no capacity correction. The siphon barometer requires no correction for capillarity. All barometers require to be corrected for temperature and altitude. The capillary action of glass and mercury cause a depression of the mercury by a quantity very nearly in inverse proportion to the diameter of the tube. The following table gives the corrections to be applied to tubes from 0.6 to 0.10 diameter, with boiled mercury:

FIG. 3.

Diameter of Tube.	Correction.	Diameter of Tube.	Correction.
0.60 inch....	0.002 inch	0.30 inch....	0.014 inch
0.50 do.	0.003 do.	0.25 do.	0.020 do.
0.45 do.	0.005 do.	0.20 do.	0.029 do.
0.40 do.	0.007 do.	0.15 do.	0.044 do.
0.35 do.	0.010 do.	0.10 do.	0.070 do.

As mercury expands $\frac{1}{55}$ of its volume between the freezing and boiling points of the Fahrenheit thermometer, it is necessary that all observations should be reduced to a uniform temperature, and for this purpose the barometer is always accompanied by a thermometer, which should be observed at each time that an observation is taken of the barometer itself. It is universally agreed that the temperature to which all barometrical observations shall be reduced is 32° Fahr. For every degree of the thermometer, above 32° Fahr., we must subtract the ten-thousandth part of the observed height. If the temperature be below 32 this correction must be added. At sea-level, in latitude 45°, and at a temperature of 32° Fahr., the normal height of the mercurial column is about 29.922. As the pressure of the atmosphere diminishes as we ascend, it is evident that the length of the mercurial column will be less in proportion to the altitude of its station. In order that observations may be intercomparable, they are reduced to the level of the sea. The correction to be applied is for the height of the column of air extending from the sea-level to that of the station. But as the weight of the column of air varies with its temperature, it is necessary to take this into consideration. Tables have been computed, giving corrections for every degree from 20° to 100°, and from sea-level to 1500 or more feet. The formulary still often found engraved upon barometer-scales—

At 31 inches	....	Very dry,
30.5 do.	....	Settled fair,
30 do.	....	Fair,
29.5 do.	....	Changeable,
29 do.	....	Rain,
28.5 do.	....	Much rain,
28 do.	....	Stormy

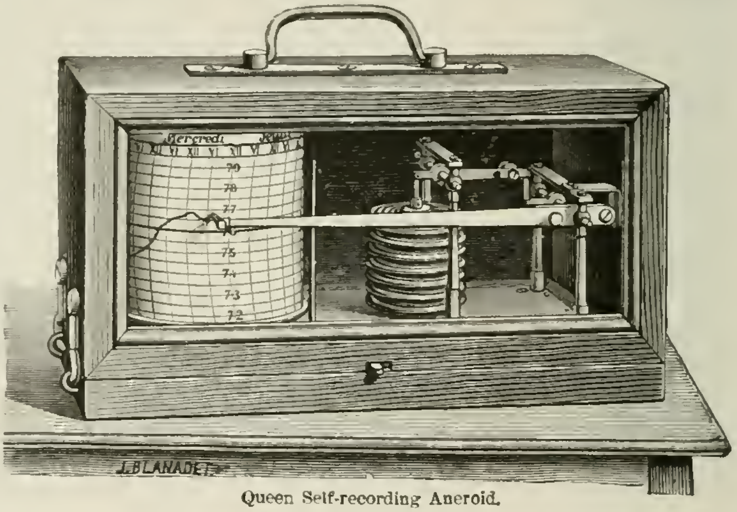
—has tended to discredit the barometer as an instrument for foretelling changes of weather. These words are useless and incorrect. The mere height of the barometer is no indication of the weather to be expected. The point to be observed is whether the barometer has risen or fallen or remained steady since the previous observation. The late Admiral Fitzroy proposed the following words for barometer-scales, which have been very generally adopted:

RISE.	FALL.
FOR	FOR
NORTH	SOUTH
N. W.-N.-E.	S. E.-S.-W.
DRY	WET
OR	OR
LESS WIND.	MORE WIND.
EXCEPT	EXCEPT
WET FROM NORTH.	WET FROM NORTH.

Generally, it may be said that when the barometer rises, owing to a change of wind, the weather gets colder, and if it remains high (above 30) the weather will probably be fair. If the barometer falls, owing to a change of wind, and remains steady at about 29.5, the weather will be warmer and wet and cloudy. A gradual rise is an indication of continued fair weather, whilst a gradual fall indicates that prolonged bad weather is to be expected. Either a very sudden rise or a sudden fall are dangerous, as they indicate a disturbance of atmospheric conditions and consequent unsettled weather. In forecasting the weather it is important that the state of the thermometer and hygrometer be observed as well as the height of the barometer, and that the direction of the wind and the time of the year be considered. Reasoning from all these factors, it is undoubtedly possible to foretell local changes with great accuracy. The best barometers in the United States are made by Messrs. James W. Queen & Co., Philadelphia.

The uses of the barometer are physical, hypsometrical, and meteorological. It is of essential use in all physical researches where the mechanical, optical, acoustical, and chemical properties of air or other gases are dependent on the pressure of the atmosphere. Its use in hypsometry, or the art of measuring the heights of mountains, is very valuable. When a barometer is at the foot of a mountain, the pressure it sustains is greater than that which it experiences at the top by the weight of the column of air intervening between the top and bottom. A formula of considerable complexity is given by mathematicians for finding very nearly the true height of a mountain from barometrical and thermometrical observations made at its base and summit, the interpretation of which does not come within the compass of this work. The following rules give very nearly the same result: 1. Reduce the mercurial heights at both stations to 32 Fahr. 2. Take the logarithms of the corrected heights, subtract them, and multiply the result by 10,000, to give the approximate height in fathoms of the upper above the lower station. 3. Take the mean of the temperature at both stations, take the difference between this mean and 32, multiply the difference by the approximate height, and divide the product by 435. This last result is to be added to the approximate height if the mean temperature is above 32, and subtracted if below, to find the true height in fathoms. See *Aneroid Barometer*.

BAROMETROGRAPH.—An instrument by which the variations of atmospheric pressure are automatically recorded on a sheet of paper. The drawing represents the Queen Self-recording Aneroid, which is remarkable for the simplicity of its construction and the accuracy of its work. It consists of an aneroid barometer, composed of a series of vacuum boxes, the movements of which are transmitted through a simple mechanism to a long lever, terminating in a metallic pen which touches a drum within which is an eight-day clock. This drum, around which is wound the record-blank, makes one revolution in seven days, so that each diagram forms a complete barometric record for the week. After winding the clock and setting the barometer, the instrument requires no attention whatever until the weekly record is finished. The pen retains enough ink to last for several weeks. The following are important advantages of this instrument: the unvarying accuracy and precision of the indications



Queen Self-recording Aneroid.

resulting from the parts specially employed; the absence of anything fragile in the apparatus, in consequence of which it is not liable to become deranged; the facility with which the instrument is set in operation, and the ease with which the record-papers can be changed; the regularity of the curves on the diagrams obtained, resulting from the special metal pen employed, which retains sufficient indelible ink to last for a month if necessary; the small size and weight of the instrument, rendering it most convenient for transportation. See *Aneroid Barometer* and *Barometer*.

BARON.—This term, as to the origin of which much difference of opinion exists, is probably derived from the Latin word *baro* (allied to *vir*, a man, a hero), which originally signified a stupid, brutal man, afterwards came to signify a man simply, and latterly, by one of those strange transmutations which are not uncommon in language, a man pre-eminently, or a person of distinction. Teutonic, Celtic, and even Hebrew derivations have also been assigned to the word; but the fact of its having been introduced into England by the Normans seems in favor of a Romanic origin. It is now the title which is applied to the lowest degree of hereditary nobility. The degree of baron forms a species of landing-place, corresponding amongst noblemen, in a certain sense, to that of gentleman, at a lower stage of the social pyramid. It was in this sense that the word was used in former times to include the whole nobility of England, because all noblemen were barons, whatever might be the higher ranks in the peerage which they occupied. The word Peer has recently come to be used with the same signification, perhaps because it is no longer necessarily the case that every nobleman should be a baron, there being instances in which earldoms and other honors have been given without a barony being attached to them, and in which the barony has been separated from the higher degree by following a different order of descent. The general theory of the Constitution, however, still is, that it is as barons that all the peers sit in the Upper House; and it is on this ground that the archbishops and bishops are said to sit in virtue of their baronies. The distinction into *greater* and *lesser* barons seems from an early period to have obtained in most of the countries of Europe. The greater barons, who were the king's chief tenants, held their lands directly, or *in capite* as it was called, of the Crown; whilst the lesser held of the greater by the tenure of military service.

BARON AND FEMME.—In Heraldry, the expression used to designate the bearing by which the arms of husband and wife are carried per pale or marshaled side by side on the same shield. The husband's arms are always carried on the dexter side. Where the wife is an heiress—i.e., the representative of her father's house—her husband carries her arms, not *per pale*, but in a shield of pretense; and they are quartered with the paternal coat by the issue of the marriage.

BAROTS.—In the construction of wire guns, barots are small hardened steel pieces placed at the termini of the wire layers, in recesses in the flanges of the steel core or body (between which the layers are placed). These barots are slotted across, the slot being of a less width (at the middle) than the diameter of the wire (which is driven into it with a hammer), so as to leave about two thirds of the strength of the wire as a bind. As the tension is about one third of the ultimate strength, sufficient tensile strength is left to securely withstand the pull of the tensed wire. See *Wire Guns*.

BARRACK-ALLOWANCE.—In the British Army, a specific allowance of bread, beef, wood, coal, etc., to regiments stationed in barracks.

BARRACK-GUARD.—When a regiment is in barracks, the principal guard is called the Barrack-guard, the Officer being responsible for the regularity of the men in barracks, and for all prisoners duly committed to his charge while on duty.

BARRACK-MASTER.—The Officer who superintends the barracks of soldiers. The condition of British soldiers has, ever since the disasters in the Crimea in the winter of 1854, been an object of much public solicitude. This solicitude was so strongly expressed as to break through the cold formalities of the official departments. Returns were ordered, and commissions and committees appointed, partly to inquire into existing facts, partly to suggest improvements. The Barrack-master-general was replaced at the beginning of this century by Commissioners for Barracks, whose functions were absorbed by the now extinct Board of Ordnance in 1822. Barracks are now under the supervision of the Surveyor-general of the Ordnance, who provides for their construction and maintenance through the Royal Engineers; and for their victualing and daily service through Commissaries of the Control Department. Under these Commissaries are Barrack-clerks and Barrack-sergeants, to assist them in their duties.

BARRACKS.—Permanent structures for the accommodation of soldiers, as distinguished from huts and tents. Originally, the word, derived from the Spanish *barracas*, applied to small cabins or huts; but in England the term is now always considered to relate to structures of brick or stone. Great opposition was made in England to the introduction of permanent barracks during the early part of the last century, on the ground that the liberty of the subject might possibly be endangered by thus separating the soldiery so completely from the citizens, and placing them in the hands of the ruling power. On the other hand, it was contended that the older system of billeting the soldiers on the people is vexatious and burdensome; and that the morals of towns-people and villagers are liable to be vitiated by the constant presence of soldiers. The permanent barracks were few in number down to the year 1792, when George III. obtained the consent of Parliament for the construction of several new ones, and for the founding of the office of Barrack-master-general. Various changes in the arrangements were made from time to time.

The furniture of the barracks is bought by the War Office. The French have a singular plan of *hiring* such furniture at 15 francs per man per annum; the English cost is about 25 shillings per man, and some Officers are of opinion that it might with advantage be superseded by the French plan. The barrack-rooms have arm and accouterment racks, shelves, and pegs; with a regular order for depositing everything thereon. During the day all the bedding is placed in exact array; as well as dishes, tins, and canteens. A Subaltern Officer visits every room every day. The iron bedsteads are turned down every evening, and up every morning. One Non-commissioned Officer (Sergeant or Corporal) has control over each room, and is responsible for quiet, cleanliness, etc. Married women, in the ratio of 6 to a company of 100 soldiers, may live in the barracks with their husbands, in separate rooms known as "Married Soldiers' Quarters," but not unless the marriage has been with consent of the Commanding Officer. The married soldier may, however, sleep out of barracks, and is allowed an extra twopence per day if he does so. Each soldier in a barrack has an iron bedstead, a rug, a paillasse, a bolster, two blankets, and two sheets; he pays nothing for these. Each soldier has his name and number written near his bed and knapsack.

Notwithstanding the order and regularity established in barracks, Committees of Inquiry appointed in 1855 and 1857 ascertained the existence of grievous defects. It was found that, out of 252 barracks, only 20 had separate sleeping-rooms for married soldiers; the wives of such soldiers, in the other 232, being obliged to put up with arrangements repugnant to all decency and propriety, or else sleep away from the barracks altogether.

In regard to sanitary arrangements, great efforts have been made at vast cost in recent years to improve all the hygienic conditions, such as drains, ventilation, means of ablution, recreation, circulation of air, etc. The result has been very apparent in the reduced rate of mortality. Army Physicians recommend 600 cubic feet of room-space per soldier; and this is the standard now demanded in all practicable cases by the War Office. It has been estimated that a new barrack for 1000 Foot-guards in London would cost £150,000 *besides land*, the cost of which would depend wholly on the particular site selected. The necessity for grounds for exercises, stores, library, offices, etc., renders a barrack a very costly congeries of buildings. Twenty acres may be taken as the minimum space needed for 1000 men. In relation to all the various subjects of barrack-life, a Committee of Military Officers has drawn up a most comprehensive scheme of reform; but unfortunately the cost of making these improvements would be so enormous that nothing better than a very gradual adoption can be expected.

The finest barracks existing are perhaps those at Aldershott, attached to the camp noticed in another article. The buildings extend in two long lines, branching out of the Farnborough and Farnham road, with a large parade-ground between them. The infantry and artillery barracks are on the north side of this space, and the cavalry barracks on the south. The infantry barracks are divided into blocks, forming each a spacious quadrangle, with a court-yard in the center. Each block is a complete barrack for a full regiment, with all the men's rooms, store-rooms, school-rooms, offices, etc. The Officers' rooms are, however, separate, and occupy open spaces between the blocks of buildings. All the four sides of each quadrangle are occupied by various rooms and buildings; the men's living and sleeping rooms being mostly on the side next to the parade-ground. The sleeping-rooms, each for 24 men, are very large and airy; the washing-rooms are ample and well-fitted; and the cooking-rooms will each cook for 350 men. Dry play-grounds and drill-yards under glass roofs are provided. A broad balcony outside every range of sleeping-rooms enables the soldiers to look out upon these grounds. The married soldiers and their wives are comfortably provided for, in rooms wholly apart from the rest. The artillery and cavalry barracks resemble in their general features those for the infantry.

In the United States Army 225 square feet of space is allowed for every six soldiers, with a height of 12 feet, giving each one about 450 cubic feet. There are few masonry-built barracks in the United States; most of them are of logs or lighter timber. Of the more permanent are Madison Barracks, at Sackett's Harbor, N. Y.; the Citadel, at Charleston, S. C.; Pensacola, at Pensacola, Fla.; Jackson, at New Orleans, La.; Jefferson, at St. Louis, Mo.; Baton Rouge Arsenal, at Baton Rouge, La.; Mt. Vernon Arsenal, Miss.; Oglethorpe, at Savannah, Ga.; Benicia, in California; Carlisle, in Pennsylvania; Fort Leavenworth, Kansas; Newport, in Kentucky; Ringgold and Fort Brown, in Texas; and the Cadet Barracks at West Point, N. Y.

An annual inspection of the public buildings at the several stations is made at the end of June by the Commanding Officer and Quartermaster, and then the Quartermaster makes the following reports: 1. Of the condition and capacity of the buildings, and of the additions, alterations, and repairs that have been made during the past year. 2. Of the additions, alterations, and repairs that are needed, with plans and estimates in detail. These reports the Commanding Officer examines and forwards, with his views, to the Quartermaster-general.

BARRACK-SERGEANTS.—Faithful old Sergeants, in the British service, who are selected from the Line and placed in charge of barracks, under the superintendence of the Barrack-masters or Commissaries of the Control Department. A similar duty is performed by roster in the United States service, the time of the detail usually being one week.

BARREL.—1. The hilt of a sword, adapted to be grasped by the hand.—2. A large vessel for holding liquids—probably from *bar* in the sense of to guard, confine, contain—and then a certain *measure*, but varying in every locality, and almost for every liquid. In the old English measures, the barrel contained 31½ gallons of wine, 32 of ale, and 36 of beer—the wine-gallon itself differing from that of ale and beer. In imperial gallons, their contents would be: old wine-barrel = 26¼ gallons; ale do., 31½; beer, 36¼. The Italian barile varies from 7 to 31 English gallons; the French barrique of Bordeaux = 228 French litres = 50 English gallons. Four barriques make a tonneau. In many cases, barrel signifies a certain *weight* or other quantity of goods usually sold in casks called barrels. In America, flour and beef are sold on the large scale in barrels: a barrel of flour must contain 196 lbs.; of beef, 200 lbs. A barrel of butter = 224 lbs.; of soft-soap, 256 lbs.; of tar, 26¼ gallons. Barrels or casks of various kinds are largely used for military purposes.—3. The barrel is the most important part of a fire-arm, its office being to concentrate the force of a charge of powder on a projectile, and give it proper initial velocity and direction; for these purposes, and for the safety of the firer, it should be made of the best materials and with the greatest care. In determining the exterior form of a barrel, it is not only necessary to give such thickness to the different parts as will best resist the explosive effort of the charge, but such as will prevent it from being bent when used as a pike or subjected to the rough usage of the service. A sufficient *weight* is required to give steadiness to the barrel in aiming, and to prevent it from springing in firing. The latter defect generally arises from bad workmanship, whereby there is a greater thickness of metal, and, consequently, less expansion, on one side of the bore than the other. In the military service, where the rifle is carried by the soldier, the barrel should seldom weigh more than five pounds.

The principal parts of a barrel are the *breech*, the *breech-screw*; the *flats*, the *bevels*, and the *oval*; the *cone*, and *cone-seat*; the *bayonet-stud*, and *front-sight*; the *bore*, the *grooves*, and the *lands*. The *breech-screw* is composed of a *body*, *tenon*, and *tang*, and its object is to close the bottom of the bore. The tenon fits into a mortise cut in the stock, and prevents the barrel from turning in its bed; the tang is the part by which the breech of the barrel is secured to the stock, and for this purpose it is pierced with a hole for the *tang-screw*, which passes through the stock and screws into the guard-plate. The *flats* are two vertical plane surfaces, situated at equal distances from the axis of the bore. They serve to prevent the barrel from turning in the jaws of the vise when the breech-screw is taken out; the flat, on the right side of the barrel, also presents a surface of contact for the lock-plate, which prevents the hammer and cone from changing their relative position. The corners of the flats are beveled to prevent the barrel from being marred, and to improve its finish. The functions of the cone are to support the percussion-cap when exploded by the hammer, and to conduct the flame to the vent of the piece. The parts are the *nipple*, upon which the cap is placed; the *square*, the part to which the wrench is applied; the *shoulder*; the *screw-thread*; and the *vent*. To increase the effect of the hammer on the cap, the upper surface of the cone is diminished by chamfering the corners. The *cone-seat* is a projecting piece of iron welded to the barrel, near the breech, for the purpose of sustaining the cone. The principal parts are the *female screw*, the *vent*, and the *rim*; the latter prevents the flame from penetrating between the lock and barrel. The position of the cone-seat should be such that the vent will have a direct communication with the bore. To prevent the blow of the hammer from straining the cone and breaking it off in the cone-seat, the plane of the face of the hammer should pass through the axis of motion.

The length of a gun-barrel is determined by the nature of the service to which it is applied, rather than by the effect which it exerts on the force of the charge. It has been shown by experiment that the velocity of a projectile, in a smooth-bored musket, increases with the length of the bore up to 108 calibers; but a musket with this length of barrel would be too heavy as a fire-arm and too unwieldy as a pike. The points to be observed in constructing the grooves for military arms are range, accuracy of fire, endurance, and facility of loading and cleaning the bore. For expanding projectiles, experiment shows that these points are best attained by making the grooves broad and shallow and with a moderate twist. The effect of decreasing the depth of rifle-grooves is to increase the accuracy, but it diminishes the range. The twist is dependent on the length, diameter, and initial velocity of the projectile; in other words, it should be increased in a certain proportion to the length of the projectile; and for the same weight of projectile it should be increased in a certain proportion as the length of the bore is diminished. See *Gun-barrel* and *Powder-barrel*.

BARREL-HEADED SIGHT.—This sight consists of a steel bar, an elevating-nut, a cross-head, two thumb-screws, and a leaf. One side of the bar is graduated to degrees, the other to yards. The degrees are divided into six parts of ten minutes each; and any number of minutes up to ten can be obtained by turning round a graduated elevating-nut on the top of the bar, which works an internal screw and so raises the head of the scale. The bar is inclined to the left to allow for *deviation*, but it is fitted with a horizontal scale or cross-head, graduated to give one half-degree of deflection either to the right or left. At each end of this slide is a graduated nut divided into minutes up to ten, and these nuts are connected by a screw which crosses the bar at right angles. A leaf with the sight-notch slides along the scale, and can be moved right or left by either nut.

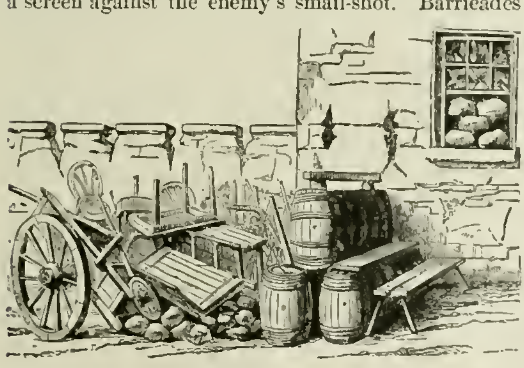
BARREL-PIERS.—Casks or barrels formed into piers, when no pontoons or boats can be obtained for the passage of troops across a river.

BARREL-PLATE.—A plate employed to hold the barrels of certain machine guns in place. In the Gatling gun, the breech-ends of all the barrels are firmly screwed into a disk, or *rear barrel-plate*, which is fastened to the shaft; while the muzzles pass through another similar disk, called the *front barrel-plate*, on the same shaft. The shaft is considerably longer than the barrels, and projects beyond the muzzles, while it extends backward for some distance behind the breeches of the barrels. See *Gatling Gun*.

BARREL-SETTER.—A cylindrical mandrel used by armorers for straightening the barrel of a fire-arm and in truing the bore or exterior surface.

BARREL-VISE.—A bench-vise having a longitudinal groove in its jaws to fit it for the reception of a gun-barrel, which may be protected from direct contact of the jaws of the vise by sheet-lead or other soft-metal cheeks.

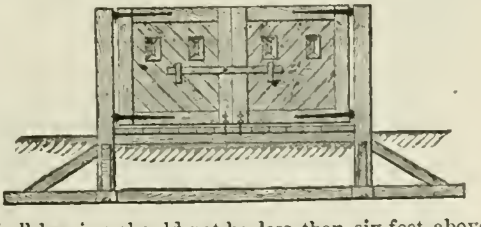
BARRICADES.—Military engineers, and sappers and miners, are instructed in the art of barricading streets and roads with beams, chains, *chevaux-de-frise*, and other obstacles, either in defending a town against besiegers, or in suppressing popular tumults. In a ship, a strong wooden rail, supported on stanchions, and extending across the foremost part of the quarter-deck, is called a barricade; during a naval action, the upper part of this barricade is sometimes stuffed with hammocks in a double rope-netting, to serve as a screen against the enemy's small-shot. Barricades



have been made use of in street-fights since the Middle Ages, but they are best known in connection with the insurrections in the city of Paris. As early as 1358 the streets of Paris were barricaded against the Dauphin, afterwards Charles V. A more noteworthy barricade-fight was that in 1588, when 4000 Swiss soldiers, marched into Paris by Henry III. to overawe the Council of Sixteen, would have been utterly destroyed by the populace, firing from behind barricades, had the Court not consented to negotiation; and the result was that the king fled next day. The next barricade-fight of importance in Paris was that of 1830, which resulted in the expulsion of the Bourbons from the throne of France, and the election of the Citizen-king, Louis Philippe. During the three days which this revolution lasted, the number of barricades erected across the streets amounted to several thousands. They were formed of the most heterogeneous materials—overturned vehicles, trees, scaffolding-poles, planks, building-materials, and street paving-stones; men, women, and children taking part in their erection. In February, 1848, the insurrection against Louis Philippe commenced with the erection of barricades; but the most celebrated and bloody barricade-fight was that between the populace and the Provisional Government, which, commencing on the night of the 23d June, 1848, lasted throughout the three following days, when the people had to surrender. The national losses by this fight were estimated at 30,000,000 francs; 16,000 persons were killed and wounded, and 8000 taken prisoners. The Emperor Napoleon III. has so widened and macadamized the principal streets of Paris since he ascended the throne as to render the successful erection of barricades next to impossible. There was a remarkable barricade-erection in London in 1821. The Ministry desired that the body of Queen Caroline should be conveyed out of the country to Germany, for interment, without the populace having the opportunity of making any demonstration. On the matter becoming known, a vast barricade was erected at the point where the Hampstead road joins the new road; and as nothing but the use of artillery could have forced the way, the officer in charge of the funeral cortege deemed it prudent to change his course and pass through a more central part of the metropolis. During the revolutions of 1848, barricades were successfully carried in Paris, Berlin, Vienna, and other places, by abandoning the attack in front and breaking through the houses of contiguous streets, taking their defenders in the rear.

BARRIERS.—Carpentry obstructions in fortifications. The purpose regulates the construction. If the barrier is to be permanently defensible, it should be musket-proof, and then becomes a *stockade*. If occasionally defensible, palisading will suffice, with a sand-bag or other temporary parapet when required, behind and near enough to fire between the palisades. The gates in both the above should, if possible, be of palisading, as the heavy stockade-gate is unwieldy. Barrier-gates should never be left unprotected.

The barrier-gate is most frequently made with two leaves, hanging on posts by hinges, and made to open inward. The frame of each upright is composed of two uprights, called *stiles;* two cross-pieces, one at the top and the other at the bottom, called *rails;* and a diagonal brace called a *swinging-bar*. Since the gate must be strong, the leaves of it are necessarily very heavy. The leaves must be hung upon stout posts firmly braced into the ground, to sustain the great weight of the gate. The top rails

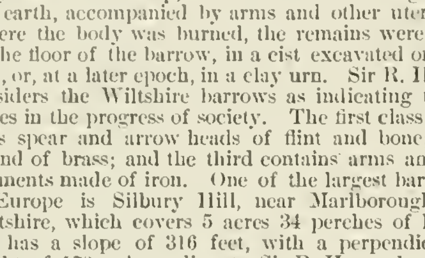


of all barriers should not be less than six feet above the ground. In the barriers with open leaves, the vertical pieces are usually extended from eighteen inches to two feet above the top rails, and their upper ends sharpened. In those which are solid, it is usual to arrange some obstruction upon the top rail, such as sharp-pointed spikes, broken glass, etc., to interfere with persons climbing over the top. It is usual to provide apertures in the leaves, through which the men can fire upon the ground on the outside.

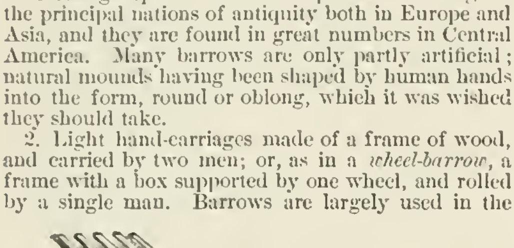
BARRITUS.—A word which not only signified the battle-cry of the ancient Germans, but all battle-cries were formerly so called. Also written *Bardites*.

BARROWS.—1. Artifical mounds of earth generally believed to have been erected for sepulchral or monumental purposes. They are very numerous in Great Britain, and many of them are supposed to belong to a period long prior to the Roman Invasion. The counties of Wilts and Dorset are especially rich in these remains, and the barrows of the former have been thoroughly explored, described, and classified by Sir R. C. Hoare in his *Ancient Wiltshire*. In the sepulchral barrows the human remains are buried either in a rude stone "cist" or chest, in which the body was doubled up, or are laid at full length in the earth, accompanied by arms and other utensils. Where the body was burned, the remains were laid on the floor of the barrow, in a cist excavated on the spot, or, at a later epoch, in a clay urn. Sir R. Hoare considers the Wiltshire barrows as indicating three stages in the progress of society. The first class contains spear and arrow heads of flint and bone; the second of brass; and the third contains arms and instruments made of iron. One of the largest barrows in Europe is Silbury Hill, near Marlborough, in Wiltshire, which covers 5 acres 34 perches of land, and has a slope of 316 feet, with a perpendicular height of 170. According to Sir R. Hoare, barrow-burial was practiced down to the eighth century, from a period of unknown antiquity. The practice of erecting sepulchral mounds prevailed among all the principal nations of antiquity both in Europe and Asia, and they are found in great numbers in Central America. Many barrows are only partly artificial; natural mounds having been shaped by human hands into the form, round or oblong, which it was wished they should take.

2. Light hand-carriages made of a frame of wood, and carried by two men; or, as in a *wheel-barrow*, a frame with a box supported by one wheel, and rolled by a single man. Barrows are largely used in the



army, there being no less than fourteen different kinds put to various purposes. The drawings show two varieties, the *rack-barrows* and *wagon-barrows*,



employed for many purposes in the arsenal and store-house.

BARRY.—In Heraldry, the term applied to a shield which is divided transversely into four, six, or more equal parts, and consisting of two or more tinctures interchangeably disposed.

Barry-bendy is where the shield is divided into four, six, or more equal parts, by diagonal lines, the tincture of which it consists being varied interchangeably.

Barry-pily is where the shield is divided by diagonal lines, the colors being interchanged as in the example.

Barry.

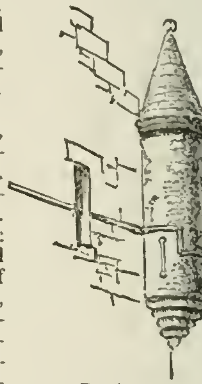
Barry-bendy.

Barry-pily.

BAR-SHOE.—A horseshoe which is not open at the heel, but continued round at the rear. It is used with horses that are liable to contraction of the heel, to spread that part of the foot.

BAR-SHOT.—A projectile formerly used, consisting of two cannon-balls, or half-balls, united by a bar of iron, and employed for severing the rigging of vessels, as well as for field and fort artillery. Shot used in proving ordnance may be considered as belonging to this class, consisting as they do of a bar with hemispherical ends, weighing twice or three times that of the solid shot used in service. See *Chain-shot*, *Projectiles*, and *Shot*.

BARTIZAN.—A small stone closet, thrown out upon corbels over doorways, and on other parts of mediæval castles, generally for defense, but sometimes only for convenience to the inmates and defenders.



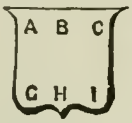
Bartizan.

BASCHI.—A Turkish title, signifying a superior commander, officer, chief, etc. This title is only used in connection with the office title. The most prominent are: Toptschijy-Baschi, General of Artillery and Inspector of Forts, etc; Solacki-Baschi, Sub-commander of the Archers; Sandschjack-Darlárs-Baschi, Chief of the 50 Color-bearers; Konadschijy-Baschi, Quartermaster-general; Boluck-Baschi, Colonel of a regiment of 1000 militia; Oda-Baschis, Company Officers who superintend drill.

BASCINET—BASNET.—A head-piece of mail, over which, in the time of Edward I. and Edward II., the helmet was worn; but in the latter reign the *bascinet* appears without the nasal of the helmet, and occasionally with a movable visor, which rendered the helmet unnecessary. Another form of the bascinet during the latter part of the thirteenth century was its being opened behind and having to be fastened or laced behind. See *Helmet*.

BASCULE BRIDGE.—A counterpoise drawbridge which oscillates in a vertical plane; the inner portion descends into a pit, while the outer ascends and closes the gateway. A bridge which has its truck simply hinged to the edge of the scarp or curbing, and which is lifted by weight or windlass, is classed as a *lifting-bridge*. The *bascule* has an inner portion of roadway, which acts as a counterpoise to the portion which projects over the water-way. The inner portion descends into a dry well when the bridge is lifted into a vertical position, the outer portion closing the opening in the wall outside of the portcullis, if there be one. This form of bridge was not uncommon in the castles of the feudal times, when the rich owned the poor, and learning had no refuge but in the Church.

BASE.—1. In fortification, the base is the exterior side of the polygon, or that imaginary line which connects the salient angles of two adjacent bastions. 2. In ordnance, the base is the protuberant rear portion of a gun, between the knob of the cascabel and the base-ring. The base is the middle member of the *cascabel* when the piece has a base-ring and knob. In the simplicity of modern pieces, many mere ornaments and extraneous matters are omitted. The base is always present, forming the rounded contour at the rear of the breech.—3. In Heraldry, the base is the lower portion of the shield. There is a dexter base,



middle base, and sinister base. The *chief* or principal part of the escutcheon is the top. The shield is always supposed to be on the arm of the wearer, and that it is his right and left hands, not those of the spectator, which are kept in view. The *ground* or surface of the shield, on which all the *charges* or figures are depicted, is called the *field.*—4. In chemistry, a term applied to a compound body, generally consisting of a metal united with oxygen. Thus, the metal potassium (K), when it combines with oxygen (O), forms the base potash (KO); sodium (Na) and oxygen, the base soda (NaO); lead (Pb) and oxygen, the base oxide of lead or litharge (PbO). A distinguishing feature of a base is that it unites with an oxygen acid, such as sulphuric acid (SO_3), to form a *salt.* Thus, the base potash (KO) combines with sulphuric acid (SO_3) to make the salt sulphate of potash ($KOSO_3$); potash with nitric acid (NO_5) to form the salt nitrate of potash, or niter ($KONO_5$). Occasionally sulphur replaces the oxygen in a base. Thus, the metal potassium (K) unites with sulphur (S) to form the *sulphur* base, sulphuret of potassium (KS), which can unite with a sulphur acid like sulpharsenious acid or orpiment (AsS_3) to make the salt sulpharsenite of potash (KS,AsS_3). The metal half of a base need not be a simple element, but may be a compound body which, for the time, plays the part of a simple substance. Thus, the compound ethyl (C_4H_5) can combine with oxygen to form ordinary ether ($[C_4H_5]O$); and the base thus produced can, in its turn, combine with acids to form salts. A base may be soluble or insoluble in water. Thus, the bases potash (KO), soda (NaO), ammonia (NH_4O), baryta (BaO), strontia (StO), lime (CaO), and magnesia (MgO), are more or less soluble in water; whilst the oxide of iron or rust (Fe_2O_3), the red oxide of lead ($PbbO_4$), the red oxide of mercury (HgO), are insoluble in water, but soluble in acids.

BASE-LINE.—In gunnery, a line traced around the gun in rear of the vent; also the measured line used to obtain ranges by triangulation. In military tactics the *base-line* is the line on which all the magazines and means of supply of an army are established. It also means the line on which troops in column move.

BASE OF OPERATIONS.—In all military operations of a general character, and which come under the head of strategy, three principal things are noticeable and demand consideration; these are the line from which the army starts in commencing its onward movements; the point which it aims to attain; and the line which it is obliged to pass over to reach this point. The first of these is termed the *base of operations;* the second, the *objective* or *objective point;* the third, the *line of operations.* When maintaining a strictly defensive attitude, the base of operations becomes what is termed the *line of defense,* and in a backward movement the line of operations becomes the *line of retreat.* The base of operations should be a series of points having the properties of military strength, as the supplies of the army for its onward movements are collected upon it; and it should have commodious lines of communication leading from it to the objective. If these strong points lie upon any natural obstacle, as a river without fords, a rugged mountainous chain, swamps, or thick primeval forests, and have an easy communication between them, the base is all the better, from the difficulties which a line of this character offers to the enterprises of the enemy in case of being thrown on the defensive. A base of some extent is better than a short one, because more latitude is given to operate against the enemy, and, if obliged to retire upon it, there is less chance of being separated from it by the enemy gaining our rear. Should it consist of a single city, for example, with but one line of operations from it, by seizing on this line the enemy might cut off the army from all supplies and reinforcements. The outline which the base assumes is far from being a matter of indifference. If it is concave towards the enemy, or has its two ends resting upon any natural impassable obstacle lying in advance of the general line, the army moving from it will find greater security for its wings than in a case where the base is either generally convex towards the enemy, or presents a salient point to him. When an army moves to a considerable distance beyond its base, it will become necessary to take up a new base in advance of the primitive one, in order to have its depots, from which it has to draw its supplies of every description, nearer at hand. This new line is termed a *secondary base of operations.* It should possess the same military properties as the primitive base, and art should supply whatever nature may be found deficient in for this purpose, in order that everything collected for the army on it may be secure. If prudence points out the necessity of taking up new bases as the army advances further into an enemy's country, it does not follow that the army should be detained to organize them on a suitable footing. This task is devolved on a body of troops left behind for this purpose, who, with the reinforcements sent forward, occupy the fortified places on the new line, erect new field-works, establish magazines, etc., while the army pursues its march to profit by its first successes. When the secondary base is not parallel to the primitive one, that end of it which is most advanced should be strengthened by every accessory means, as it is the one most exposed to the enemy's attacks. The other end, though less exposed, from its retired position, also affords less support to the army in advance. An oblique base affords the advantage of threatening the communications and base of the enemy without exposing our own. The base of operations can seldom be a subject of doubt in a foreign war, as it necessarily lies on that portion of the frontier next to the enemy. The only question that can arise is at what point of the frontier it will be best to advance against the enemy. It is here that a consideration of the general outline of the base comes up. Is it concave, or makes to some extent a re-entering angle, the army then in advancing will find both its rear and wings securely supported. Is it strongly convex, or offers a salient angle, it has the advantage, by assembling our army towards the apex of the angle, of keeping the enemy in doubt as to which side we will adopt for our base, and thus forcing him to distribute his forces on an arc of which we occupy the center. But even should he concentrate on one point, we have still the resource of threatening him on one side, so as to draw his attention there, while by the shortest line we throw ourselves on the opposite one. This convex form is then decidedly advantageous on the opening of a campaign; but, in case of reverse, it may lead to our separation from our base. The inverse holds for the concave base. There can seldom, if ever, be an equality of choice between two frontiers as a base of operations; one will necessarily offer preponderating advantages over the other, which will cause its adoption, and it is upon this one that all our means of attack must be brought together. It is a grave fault to pursue a double offensive, in starting at the same time from two bases. It is much better to stand strictly on the defensive on one of the frontiers, so that by accumulating more troops on the other we may increase our chances of success. It is a rare thing that we arrive at a satisfactory result by dividing our forces; and the same reasons which render double lines of operation dangerous are equally against attempting a double offensive. We should, on the contrary, concentrate our efforts as much as we can, in order that the advantages we obtain may be decisive; and they must always be more so on the preponderating frontier than on the other; it is upon the former, therefore, that we should act with the most vigor, holding back from the other all that is not indispensable to the defensive; as upon the field of battle we refuse one wing, drawing from it troops to strengthen the one engaged, and upon which we count for victory. See *Line of Operations* and *Objective Point.*

BASE OF THE BREECH.—In gunnery, the rear surface of the breech of a gun. See *Piece.*

BASE-RING.—A projecting band of metal adjoining the base of the breech, and connected with the body of the gun by a concave molding. It serves as a point of support for the breech-sight, and rests upon the head of the elevating-screw. The ring is omitted in guns of recent model. See *Cannon.*

BASHAW.—A Turkish title of honor given to Viceroys, Provincial Governors, Generals, and other distinguished public men. The term Bashaw is also used to characterize a man of an arrogant and domineering disposition.

BASHI-BAZOUKS.—Irregular troopers in the pay of the Sultan. Very few of them are Europeans; they are mostly Asiatics, from some or other of the Pashalics in Asiatic Turkey. They are wild, turbulent men, ready to enter the Sultan's service under some leader whom they can understand, and still more ready to plunder whenever an opportunity offers. During the Russo-Turkish war of 1854, etc., they had many encounters with the enemy in that kind of irregular warfare which the Russians intrust to Cossack horsemen; but the peaceful villagers had almost as much distrust of the Bashi-bazouks as of the Russians. When the British Government resolved, in 1855, to take into pay a Turkish contingent, to aid in the operations of the war, a Corps of Bashi-bazouks was put in charge of an Indian officer, but the task of reducing them to discipline was not completed when the war ended. Their ferocity was exhibited in the Servian war, but most relentlessly in the massacre of Batak, where, in May 1876, under Achmet Agha, they slew over 1000 defenseless Bulgarians in a church in which they sought refuge.

BASHFORTH CHRONOGRAPH.—Professor Bashforth of the Artillery School, Woolwich, England, has made extensive experiments to determine the resistance of the air to the motion of rifle-projectiles, with a chronograph of his own invention. A general view of his instrument is given in Fig. 1.

The fly-wheel, A, is capable of revolving about a vertical axis, and carrying with it the cylinder, K, which is covered with prepared paper for the reception of the clock and screen records. The length of the cylinder is 12 or 14 inches, and the diameter 4 inches. B is a toothed wheel which gears with the wheel-work, M, so as to allow the spring, CD, to be slowly unwrapped from its drum. The other end of CD, being attached to the platform, S, allows it to descend slowly along the slide, L, about $\frac{1}{4}$ inch for each revolution of the cylinder. E, E′ are electro-magnets; *d, d′* are frames supporting the keepers; and *f, f′* are the ends of the springs, which act against the attraction of the electro-magnets. When the current is interrupted in one circuit, as E, the magnetism of the electro-magnet is destroyed, the spring, *f*, carries back the keeper, which by means of the arm, *a*, gives a blow to the lever, *b*. Thus the marker, *m*, is made to depart from the uniform spiral it was describing. When the current is restored, the keeper is attracted, and thus the marker, *m*, is brought back, which continues to trace its spiral as if nothing had happened. E′ is connected with the clock, and its marker, *m′*, records the seconds. E is connected with the screen, and records the passage of the projectile through the screens. By comparing the marks made by *m, m′*, the exact velocity of the projectile can be calculated at all points of its course. The slide, L, is fixed parallel to F, and the cylinder, K, by the brackets, G, H. Y is a screw for drawing back the wheel-work, M; and J, a stop to regulate the distance between M and B. The depression of the lever, *h*, raises the two springs, *s*, which act as

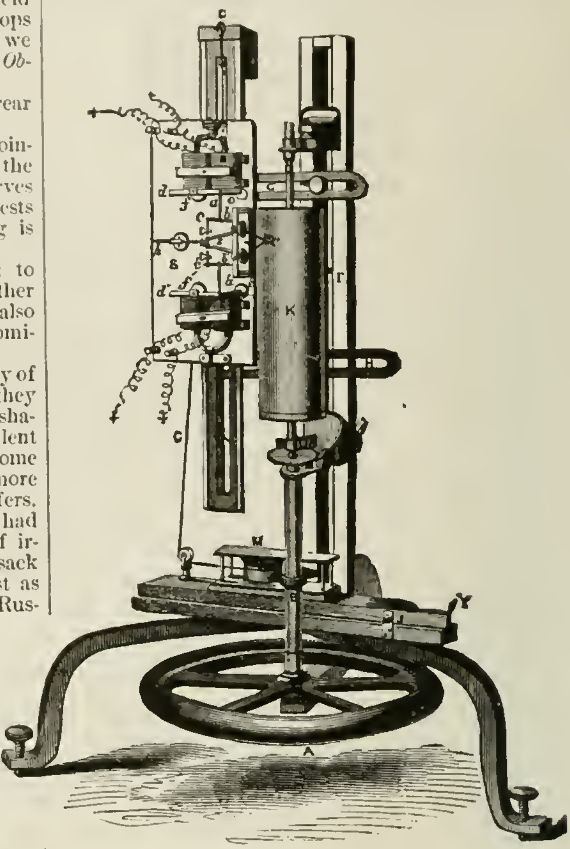


Fig. 1.

levers, and bring the diamond points, *m, m′*, down upon the paper. When an experiment is to be made, care is taken to see that the two currents are complete. The fly-wheel, A, is set in motion by hand, so as to make about three revolutions in two seconds. The markers, *m, m′*, are brought down upon the paper, and after four or five beats of the clock the signal to fire is given, so that in about ten seconds the experiment is completed, and the instrument is ready for another. The pendulum of a half-seconds clock strikes once, each double-beat, a very light spring, and so interrupts the galvanic current in E′ once a second.

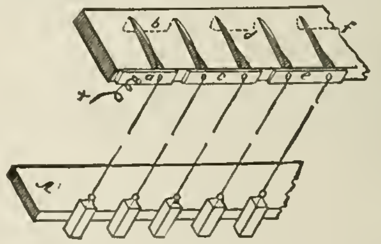


Fig. 2.

Fig. 2 gives the details of the screen. It represents a piece of board 1 inch thick and 6 or 7 inches wide, and rather larger than the width of the screen to be formed. Transverse grooves are cut at equal distances, something less than the diameter of the projectile. Staples of hard brass spring-wire are fixed with their prongs in the continuation of the grooves. Pieces of sheet-copper, *a*, *c*, *e*, are provided, having two elliptical holes, the distance of whose centers equals the distance of the grooves. The pieces of copper are used to connect each wire staple, *b*, *d*, *f*, with its neighbor on each side. These copper connections hold down the wire springs, which, when free, are in contact with the tops of the holes; but, when properly weighted, they rest on the lower edges of the holes. Thus the copper, *c*, forms a connection between the staples, *b* and *d*; the copper, *e*, joins *d* and *f*, and so on. A galvanic stream will therefore take the following course, whether the springs be weighted or unweighted: copper *a*, brass *b*; copper *c*, brass *d*; copper *e*, brass *f*, etc. The current will only be interrupted when one or more threads have been cut, and the corresponding spring is flying from the bottom to the top of its hole. About one fiftieth of a second is required for the complete registration

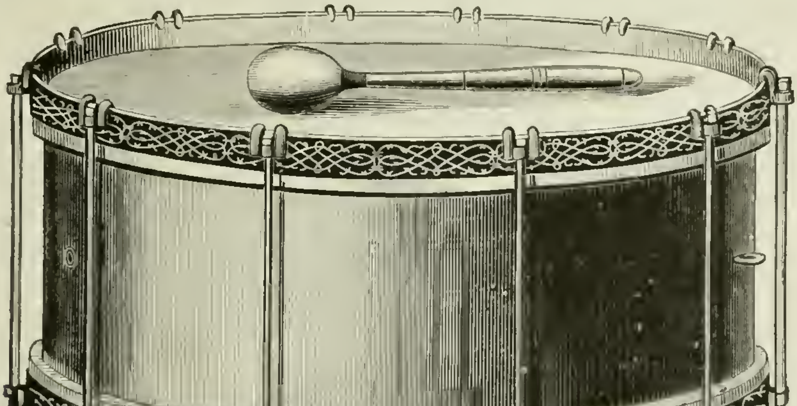
Fig. 3.

of such an interruption, the spring traversing about half an inch. The shelf, A, is placed for the weights to rest against, partly to prevent them from being carried forward by the projectile, but chiefly to prevent the untwisting of the threads which support the weights. The weights used are about 2 lbs. each, and the strength of sewing-cotton for supporting them is equal to a stress of about 3 lbs., which is sufficient to withstand a tolerably strong wind. As the weights are equal, the threads are kept equally stretched. The arrangement of *screens* for an experiment is shown in Fig. 3. The wires for conveying the galvanic current are like the common telegraph-wires carried on posts. *a b c d e f g h* is a continuous piece of wire, and the current is made to circulate through the screens. The ends, *a*, *h*, are connected with the instrument and battery. The projectile, being fired through the screens, in passing cuts one or more threads at each screen, so that, corresponding to the instant at which the projectile passes each screen, there is an interruption of the galvanic current, and a simultaneous record on the paper. See *Chronoscope*.

BASHKIRS—BASHKURTS.—A people in Orenburg and Perm, Russia, on the slope and plains of the Ural. They are a mixture of Finns, Tartars, and Ostyaks. Until the arrival of the Hungarians, about the middle of the thirteenth century, the Bashkirs were strong and independent and troublesome to their neighbors. In 1556 they voluntarily accepted the supremacy of Russia, and the city of Upha was founded to defend them from the Kirghiz. Three times they rebelled, in 1676, 1707, and 1735, but were reduced to subjection. They are now divided into thirteen cantons, under the jurisdiction of the Governor-general of Orenburg. They maintain a military cordon, escort caravans through the Kirghiz steppes, and are employed in various other services. They are divided into settled and nomadic, the former chiefly agriculturists, and the latter cattle-raisers. They are hospitable, but suspicious, poor, apt to steal, and exceedingly lazy. They have large heads, small foreheads, eyes narrow and flat, ears standing straight out, and black hair; but are muscular and strong, and capable of enduring much labor and privation. They are of limited intellect, and their Mohammedanism is rather a profession than a practice.

BASIL.—Tanned sheep-skin, used for various purposes in the arsenal and armory.

BASILICON.—A name given to an ointment composed of yellow wax, black pitch, resin, and olive-oil; hence it was called *unguentum tetra-pharmacum* (*tetra pharmaka*, four drugs). The resin, wax, and pitch are melted together over a slow fire; the oil is then added, and the mixture, while hot, strained through linen. The straining is directed in consequence of the impurities which resin often contains. Basilicon ointment, or resin cerate as it is sometimes called, is much used as a gently stimulant application to blistered surfaces, indolent ulcers, burns, scalds, and chilblains, and other accidents of the march and camp.



Bass-drum.

BASILLARD.—An old term for a poniard or dagger.

BASILISK—BASILISKE.—An ancient piece of ordnance, which was ten feet long and weighed 7200 pounds; so called from its supposed resemblance to the serpent of that name, or from its size.

BASKET-HILT.—The hilt of a sword, so made as to contain and guard the whole hand. The term "basket" is given to the leather guard round the handle of fencing or single sticks, and the leather of condemned pouches is often applied to this purpose.

BASKET-WORK.—In fortification, work involving the interweaving of withes and stakes: such as wicker-work, randing, wattling, waling-gabions, fascines, hurdles, etc.

BASLARD.—A short sword or dagger, worn in the fifteenth century.

BASSART.—An arm-guard worn by knights and soldiers in the Middle Ages.

BASS-DRUM.—A very large drum, beaten at either end, and used chiefly in military bands. The invention of the drum in this form is ascribed to Bacchus, who, according to Polygoenus, gave his signal of battle by cymbal and drum. It was, however, known in very early ages, and in some rude form among almost all nations.

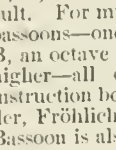
BASSINET.—The pan of the arquebus. The priming is placed in the *bassinet* and covered by another plate called the *couvre-bassinet*.

BASSOON.—A well-known wind-instrument of the reed species, made of maple-wood or plane-tree. The bassoon is an Italian invention; its name, fagotto, meaning *a bundle*, probably from its being made in different pieces laid one against the other. The French call it *basson de hautbois;* the Germans retain its Italian name. Its invention is attributed to Canonicus Afranio, in Ferrara, in 1539. In the middle of the sixteenth century it had already reached great perfection. Sigmund Schnitzer, in Nuremberg, who died in 1578, was a celebrated maker. The bassoon consists of a bored-out tube of wood in several pieces, fixed together alongside each other, so as to bring the holes and keys within the reach of the fingers of each hand. The bassoon has, in general, not less than eight holes and ten keys. In the narrow end of the wooden tube is fixed a small tapering brass tube in the form of an S, on the end of which is placed the reed for producing the tone. The notes for the bassoon are written on the bass clef for the lower part, and on the tenor clef for the higher. The best keys for the bassoon are E flat, B flat, F, C, G, D, and A; all the other keys are more or less difficult. For military bands there are different sizes of bassoons—one a fourth lower; another, the contra B, an octave lower; and a third, the tenor B, a fifth higher—all of the same construction. The best instruction books for the bassoon are by Almenräder, Fröhlich, Ozi, and by the Paris Conservatorium. Bassoon is also the name of an organ-stop, the pipes of which are made to imitate the tones of the instrument.

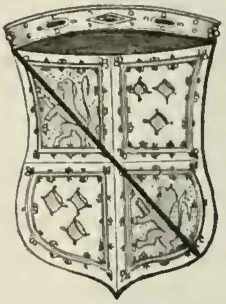
Bassoon.

BASTARD.—An ancient piece of ordnance of about 8 pounds caliber, 9½ feet long, and weighing 1950 pounds. It was invented by Jean Manrique de Lard, Master-general of Ordnance under Charles V. of France, in 1535. He also had several bastards cast of a larger caliber. This term was also applied to guns of an unusual make or proportion, whether longer or shorter.

BASTARD BAR.—In popular speech we frequently hear of a *bar-sinister*, as a mark of bastardy. But a bar-sinister, strictly speaking, is an impossibility, inasmuch as the bar is not formed of diagonal but of horizontal lines. A *bend-sinister*, which by the French is called a bar, has with more reason been confused with the true mark of illegitimacy, and has on that account been avoided even by heralds. But the real bastard bar differs very essentially from the bend-sinister, being half of the scarp, which again is half of the bend-sinister. "The half of the scarp," says Nisbet, "with the English is called a Batton-sinister; by the French, Baston-sinister; it is never carried in arms but as a mark of illegitimation, commonly called the Bastard-barr." In modern practice the baton does not touch the extremities of the shield, or of the quarter in which the paternal arms are placed, but is *couped*—that is, cut short at the ends. In this form the baton, when used as a mark of illegitimacy, is placed over the paternal coat of the bastard, whether used singly or in a quartered shield. Nisbet informs us that the baton-sinister, both in England and Scotland, is comparatively of modern invention, natural children in earlier times not having been permitted to assume the arms or even the names of their fathers. "The unlawful children of John of Gaunt, Duke of Lancaster, begot on Katharine, daughter of Sir Payen Roat Guyn, King of Arms, did not carry the arms of their father the king, though nobilitate, with a baton-sinister, as now used; . . . but after the legitimation of these three natural sons by Act of Parliament, they then assumed the sovereign ensigns of England, within a bordure gobbonated argent and azure." According to the practice of France, which probably was followed in England also, the bastard could not cancel or alter the baton without the consent of the chief of the family or the authority of the sovereign. Even where the baton was not removed, it was common for the sovereign to grant his permission to carry it *dexter*, in place of sinister. Charles VII. of France allowed John, the Bastard of Orleans, for his valor against the English, to turn his sinister traverse to the dexter, with which he and his issue afterwards *bruised* the arms of Orleans, as dukes of Longueville. The same privilege was granted to James, Earl of Murray, natural son of King James V. of Scotland, by his sister Queen Mary, and he thenceforth carried the Lion and tressure of Scotland thus bruised, quartered with the feudal arms of the earldom of Murray. The general practice of the milder heraldry of our own day is to substitute the gobbonated bordure for the bastard bar, not only in the case of the legitimate children of bastards, but of bastards themselves.



Bastard Bar.



Earl of Murray's Arms.

BASTARD-CULVERIN.—A cannon of the French artillery, under Henry II., carrying a projectile weighing 7 pounds 2¼ ounces.

BASTARDEAU.—The small knife often seen on the sheath of the *anelace*.

BASTARD FILE.—A file much used in the armory, of a grade between the *rough* and the *smooth*, in respect of the relative prominence and coarseness of the teeth. The order is as follows: rough, middle-cut, bastard, second-cut, smooth, and dead-smooth. The angle of the chisel in cutting the bastard file is about 10° from the perpendicular. The number of cuts to the inch varies with the length of the file in inches.

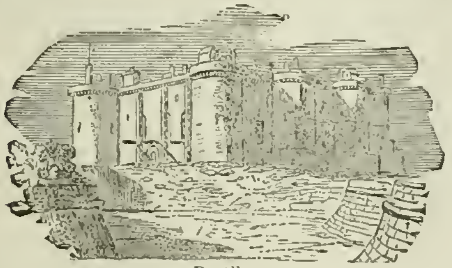
Inches.........	4	6	8	12	16	20
Cuts...........	76	64	56	48	44	34

See *File*.

BASTERNA.—The *basterna* of the Romans was a litter or species of sedan, carried by two mules, differing from the lectica in that the latter was borne by slaves. The name is derived from a people of the Carpathian Mountains, and was afterwards applied to a species of ox-cart or wagon used by the early kings of France. The name survives in a modern European carriage.

BASTIDE.—In ancient times, a bastion, a block-house, a fortress, or other fortification.

BASTILE—BASTILLE.—In France, a general term for a strong fortress defended by towers or bastions, and in this sense it was used in England also after the Norman Conquest. The famous prison to which the name latterly was appropriated was originally the Castle of Paris, and was built by order of Charles



Bastile.

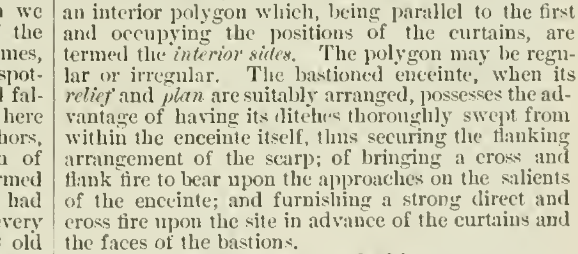
V., between 1370 and 1383, by Hugo Aubriot, Prévôt or Provost of Paris, at the Porte St. Antoine, as a defense against the English. Afterwards, when it came to be used as a State Prison, it was provided, during the sixteenth and seventeenth centuries, with vast bulwarks and ditches. On each of its longer sides the Bastile had four towers, of five stories each, over which there ran a gallery, which was armed with cannon. It was partly in these towers and partly in cellars under the level of the ground that the prisons were situated. The unfortunate inmates of these abodes were so effectually removed from the world without as often to be entirely forgotten, and in some cases it was found impossible to discover either their origin or the cause of their incarceration. The Bastile was capable of containing 70 to 80 prisoners, a number frequently reached during the reigns of Louis XIV. and Louis XV. Though small compared to the number which an ordinary prison contains, these numbers were considerable when we reflect that they rarely consisted of persons of the lower ranks, or such as were guilty of actual crimes, but of those who were sacrificed to political despotism, court intrigue, ecclesiastical tyranny, or had fallen victims to family quarrels, and were lodged here in virtue of *lettres-de-cachet*—noblemen, authors, savans, priests, and publishers. On the 14th of July, 1789, the fortress was surrounded by an armed mob, which the reactionary policy of the Court had driven into fury, and to the number of which every moment added. The garrison consisted of 82 old soldiers and 32 Swiss. The negotiations which were entered into with the Governor led to no other result than the removal of the cannon pointed on the Faubourg St. Antoine, which by no means contented the exasperated multitude. Some cut the chains of the first drawbridge, and a contest took place, in which one of the besieged and 150 of the people were killed, or severely wounded; but the arrival of a portion of the troops which had already joined the people with four field-pieces turned the fortune of the conflict in favor of the besiegers. Delaunay, the Governor—who had been prevented by one of his officers, when on the point of blowing the fortress into the air—permitted the second drawbridge to be lowered, and the people rushed in, killing Delaunay himself and several of his officers. The destruction of the Bastile commenced on the following day, amid the thunder of cannon and the pealing of the Te Deum. This event, in itself apparently of no great moment, leading only to the release of three unknown prisoners—one of whom had been its tenant for thirty years—and four forgers, and in which it is said only the 654 persons whose names now appear on the column in the Place de la Bastille took part, nevertheless finally broke the spirit of the Court Party, and changed the current of events in France.

BASTINADO.—The name given by Europeans to the punishment in use over the whole East, which consists in blows with a stick, generally upon the soles of the feet, but sometimes upon the back.

BASTION.—The precise period that the bastioned system of fortification appeared is not known, but it is generally conceded to have appeared about the time that gunpowder was first used for military purposes. The bastions constructed in 1525 in Verona are among the oldest known. The improvements made in siege-artillery towards the end of the sixteenth century caused Sully, the Prime Minister of France, Grand-master of Artillery and Superintendent of Fortifications, to take measures to modify and strengthen the fortifications then existing in France. His first step was to take them out of the hands of those who had them in keeping, and to put them in the charge of a select body of men, who had military experience, education, and knowledge of construction. From this body of men we date the origin of the French Corps of Engineers, and this period may be regarded as the beginning of the bastioned system in France. The noted military engineers, Errard, of Bar le Duc, De Ville, and Count de Pagan, were successively charged with these modifications and left their impress upon the works intrusted them. They were followed by Vauban, and he by Cormontaigne. Although modifications have been made in the bastioned system since the time of Cormontaigne, we can safely say that its essential basis is that of his method. A knowledge of the bastioned system would not be complete without an acquaintance with his method and those of Vauban.

A bastioned enceinte consists of a series of bastions, A, B, etc., which occupy the salient angles of the polygon within which the enceinte is inclosed; the flanks of the bastions being usually connected by straight curtains. The sides of the polygon which connect the salient angles of the bastions are termed the *exterior sides*, in contradistinction to the sides of an interior polygon which, being parallel to the first and occupying the positions of the curtains, are termed the *interior sides*. The polygon may be regular or irregular. The bastioned enceinte, when its *relief* and *plan* are suitably arranged, possesses the advantage of having its ditches thoroughly swept from within the enceinte itself, thus securing the flanking arrangement of the scarp; of bringing a cross and flank fire to bear upon the approaches on the salients of the enceinte; and furnishing a strong direct and cross fire upon the site in advance of the curtains and the faces of the bastions.

It is not safe to base the flanking arrangements solely upon artillery. The fire of musketry is more



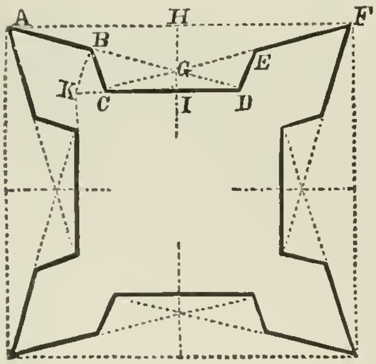
A, B.—Bastions.	KL.—Curtain.
EF.—Exterior side.	EL.—Line of defense.
NO.—Interior side.	SEI.—Salient-angle.
PQ.—Perpendicular.	EIK.—Shoulder-angle.
EI.—Face.	IKL.—Curtain-angle.
IK.—Flank.	IEP.—Diminished angle.

deadly and more effective, and upon it these arrangements are based. Its effective range, the ordinary limits of distinct vision, and the skill in using this arm are all to be considered. Supposing the enemy able to gain a position within 50 yards of the salient, he should there be within range of the musketry-fire of the flanks. With the improved arms of the present time, we may assume this distance to be 300 yards. The musketry may be supplemented by Gatling guns, or other inventions of the same nature, but the basis of the flanking arrangements must be the arm used by the infantry soldier.

The position of the flank will vary between the limits, a perpendicular to the curtain, and a perpendicular to the opposite face let fall from the point where the curtain intersects the line of defense. A position intermediate to these has been generally adopted; in most cases, placing *the flank so as to make an angle of about* 100° *with the curtain*. The length should be sufficient to allow it to be armed with at least two pieces of artillery; this will determine the least length of flank. It may be increased beyond this, to any extent demanded by the circumstances of the defense. From the effect had in so doing to increase the length of curtain and to diminish the interior space in the bastion, the *maximum length* has been restricted to 50 *yards*.

The face of the bastion is usually directed on the curtain-angle. In this case the entire fire of the flank can be brought to bear on the enceinte-ditch along the foot of the scarp-wall of the face. Circumstances may require a different position: directing it on some point on the curtain, or on some point on the flank. With the advantages gained there will be corresponding disadvantages. Their relative values will decide it. The relative positions of the curtain, flanks, and lines of defense, and their respective lengths affect the length of the faces. If the line of defense is equal only to the distance between the curtain-angle and opposite shoulder-angle, the corresponding length of face will be zero; if the curtain and the flanks have their least and the line of defense its greatest length, the resulting face will be the longest that we can have.

BASTIONED FORTS. — The bastioned fort has been devised to remedy defective flanked dispositions. It may consist of a polygon of any number of sides, but for field-forts the square and pentagon are generally preferred. To plan a work of this



kind, a square or pentagon is first laid out, and the sides bisected by perpendiculars, HI; a distance, GH, of one eighth of a side in a square (one seventh in a pentagon) is set off on the perpendiculars; from the angular points of the polygon, lines DA, CF are drawn through the points thus set off: these lines give the direction of the lines of defense; from the salients of the polygon, distances equal to two sevenths of a side are set off on the directions of the lines of defense, which give the faces; from the extremities of the faces the flanks are drawn perpendicular to, or making an angle of 110 with, the lines of defense; the extremities of the flanks are connected by curtains, CD.

In deciding on the general plan to be carried out, the following considerations require attention: the object the work is expected to fulfill, and its situation with respect to the enemy; whether it is likely to be attacked by overwhelming forces; whether artillery is likely to be brought against it, or infantry, and whether it can be surrounded; the number of men there will be for its defense, observing that it is better to have a force concentrated, and that it is therefore injudicious to make works of a greater extent than can be well manned and vigorously defended. Another consideration that must not be omitted is the number of men that can be collected for working, whether they are one's own men or inhabitants, and whether there are tools enough and time enough to do it.

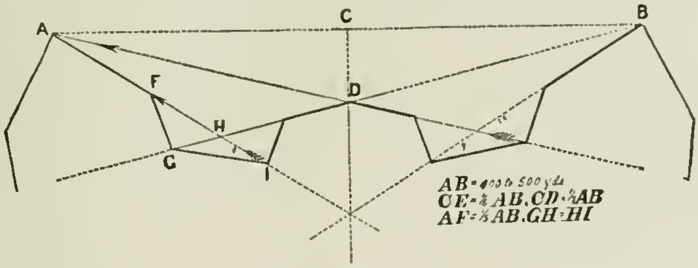
An examination of the arrangement of a bastioned front will show that there are neither dead-angles nor sectors without fire; that the salients, and all the ground within the range of fire, are protected by formidable columns of direct, flank, and cross fire. There is one point in this system that demands particular attention, which is, that the counterscarp of the ditch, if laid out parallel to the interior crest, would form a dead-angle along each face near the shoulder; because the fire of the flank would be intercepted by the crest of the counterscarp. To prevent this, either the counterscarps of the faces must be prolonged to intersect, and all earth between them and the scarp of the flanks and curtain be excavated, or the ditch of each face must be inclined up in a slope from the bottom, opposite the shoulder, so that it can be swept by the fire of the flank. The first method is the best, but requires most labor; the second is chiefly objectionable as it gives an easy access to the ditch, which might be taken advantage of in an assault. It is proposed, to obviate this, to dig a second ditch at the foot of the slope across the main ditch, twelve feet wide and about six feet deep; to make it pointed at the bottom, and to plant a row of palisades in it.

Forts have been proposed with half-bastions, but, being very little superior to the redoubt and much more difficult of construction, they ought never to be used. The exterior sides of the bastioned fort should not exceed 250 yards, nor be less than 125 yards, otherwise the flanking arrangements, with the smoothbore musket in the former case, and the flanks too short in the latter, will be imperfect. With a relief of twenty-four feet, which is the greatest that, in most cases, can be given to field-works, and an exterior side of 250 yards, the ditch of the curtain will be perfectly swept by the fire of the flanks, the lines of defense will be nearly 180 yards, a length which admits of a good defense, and the flanks will be nearly thirty yards. With a relief of fourteen feet, the least that will present a tolerable obstacle to an assault, and an exterior side of 125 yards, the ditch of the curtain will be well flanked, the flanks will be nearly twenty yards in length, and the faces between thirty and forty yards. Between these limits, the dimensions of the exterior side must vary with the relief. See *Fortification*.

BASTIONED LINE.—Owing to the imperfect flanking arrangements of other lines, it has been proposed to use bastioned lines. They are laid out by placing the salients 250 yards apart, and making the perpendicular of the front equal to one sixth.

Another arrangement of the bastioned line, shown in the drawing, has *double flanks*. The salients, in this case, should be between 400 and 500 yards apart. The drawing explains itself. By this arrangement there are fewer assailable points on the same front; one of the bastions is placed in a strong re-entering; and the salients of the advanced bastions are protected by the flank fire of the collateral advanced bastion, and also of the retired bastion. The principal objection to the bastioned line is its great development, and the consequent increase of labor and time for its construction. This objection, however, does not apply to a front of limited extent where the flanks of the line rest upon natural features like unfordable water-courses, or upon an impassable marsh which will prevent the line from being turned.

Continued lines are not suited to an active defense; and this is a grave objection to their use. Moreover, from the great dissemination of the troops over a long defensive line, the resistance at all points will be weak, and if one point is carried the rest of the line is taken in flank. Besides, the main reserve being at the center, the flanks may fail to receive timely succor if attacked. The enemy, if repulsed by their fire, can retreat in good order, and renew the assault at a more opportune moment; because the assailed, if they attempt a sortie, must defile through narrow outlets, and present a feeble front to the enemy during the operation of defiling. They are, however, the best defensive means for irregular troops, owing to the confidence which they inspire. They also serve to guard against a surprise, and to prevent the predatory excursions of small detachments of the enemy. See *Lines.*



Bastioned Line.

BASTIONET.—A small bastion in masonry, either casemated or open and placed at the salient of a work. When casemated, the masonry should be covered by the glacis.

BASTION-FACE CUT.—The object of this cut is similar to the one in the demi-lune face; it confines the enemy to the salient part of the bastion, preventing him from extending his works along the bastion terre-plein, to turn the cavalier by its gorge; so that to obtain possession of this work he must make a breach in its face. The arrangement of the ditch of the cavalier frequently subjects only a part of it to the fire of the parapet behind the cut. This dead space might offer some advantages were the enemy to attempt to carry the parapet of the cut by escalade. To remedy this defect, it has been proposed to place a crenated gallery behind the scarp-wall of the cut, to flank the entire ditch. By placing the door of the postern that leads into the cavalier-ditch at the point where the vertical wall separates the two levels, it will be partially covered from the enemy's lodgment on the bastion terre-plein. The disposition of the cavalier and cuts within the bastion does not leave sufficient space upon the terre-plein of the latter to organize a covered-way. But in the retrenchments of open bastions, resting on the flanks or curtains, to which the form of a tenaille or small bastioned front is given, a covered-way, with a re-entering place-of-arms closed by traverses, can be organized, which will give considerable additional confidence and security in the defense of the breach in the bastion with the bayonet. The organization of these covered-ways presents no peculiarity. They should, as far as practicable, be defiled from the besieger's lodgments within the bastion assailed. See *Demi-lune Cut.*

BASTON.—1. A formidable club which was used as a war-club in the early Norman battles. It was not an unusual weapon at that period, and seems to have been the precursor of the iron mace of the Middle Ages.

2. In Heraldry, a staff or cudgel generally borne as a mark of bastardy, and properly containing one eighth in breadth of the bend-sinister.

BAT.—The name of a kind of pack-saddle; and hence a bat-horse was a baggage-horse bearing a bat or pack, and a bat-man was a servant in charge of the horse and bat. By a modification of meaning, a bat-man is now any soldier allowed to act as servant to an officer. When British troops are sent on foreign service, bat-horses or mules are provided (if carriages are not forthcoming) for carrying the regimental books, the kettles, the tents, the medicine-chest, the veterinary medicine-chest, intrenching-tools, armorers' stores, saddlers' stores, etc.—about twenty such horses or mules to each battalion. Bat-horses and bat-men are also provided for carrying officers' camp-equipage. An allowance for procuring these accommodations is usually called bat-money.

BATAGE.—The time employed in reducing gunpowder to its proper consistency. The French usually consume 24 hours in pounding the materials to make good gunpowder. Supposing the mortar to contain 16 pounds of composition, it would require the application of the pestle 3500 times each hour. The labor required in this process is less in summer than in winter, because the water is softer.

BATAILLON DE LA SALADE.—A name formerly given in France to old corps which wore a peculiar kind of helmet called *salade.*

BATARDEAU.—A strong wall of masonry, built across the outer ditch of a fortress, to sustain the pressure of water when one part of the ditch is dry and the rest wet. It is built up to an angle at the top, and is armed with spikes, to prevent the enemy from crossing; and sometimes a stone tower is provided to strengthen the defense. There is a sluice-gate to regulate the admission of water.

BAT DE MULET.—A pack-saddle used in service when mules are employed to carry stores. Aparejos in the United States service are used for a similar purpose. See *Aparejo.*

BATEAU-BRIDGE.—A floating bridge supported by bateaux or light boats. See *Ponton.*

BATEAU D'AVANT-GARDE.—A small light boat attached to the advance-guard of an army. It is 33 feet in length by 5 feet 6 inches in breadth.

BATH.—The name of the Order of the Knights of the Bath is derived from the ceremony of bathing, which used to be practiced at the inauguration of a knight, as an emblem of the purity henceforth required of him by the laws of chivalry. The ceremony is of rather unknown antiquity, and is spoken of by writers of the thirteenth century as a very ancient custom. The earliest authentic instance of its observance which we have is in the time of Henry IV., who, in preparing for his coronation, made forty-six knights at the Tower of London, who had watched all the night before, and bathed themselves. The last Knights of the Bath created in the ancient form were at the coronation of Charles II. in 1661. From that period till the accession of the House of Hanover, the order fell into oblivion.

Star of the Bath.

It was revived by George I. in 1725, and is now the second order in rank in England, the first being the Garter. By the statutes then framed for the government of the order, it was declared that, besides the Sovereign, a prince of the blood, and a great master, there should be thirty-five knights. At the conclusion of the great war, it was thought expedient, with a view to rewarding the merits of many distinguished officers, both military and naval, to extend the limits of the order, which was effected on the 2d January, 1815. But the order was still purely military, and it was not till 1847 that it was placed on its present footing by the admission of Civil Knights, Commanders, and Companions. The following is its present organization:

First Class.—Knights Grand Cross (K.G.C.); the number not to exceed, for the military service, 50, exclusive of the royal family and foreigners; and for the civil service, 25.

Second Class — Knights Commanders (K.C.B.); military, 102, and civil, 50, exclusive of foreigners. These, like the first, have the title *Sir*, and take precedence of Knights Bachelors.

Third Class.—Companions (C.B.); military, 525, and civil, 200. They take precedence of Esquires, but are not entitled to the distinctive appellation of knighthood. No Officer can be nominated to the military division of this class unless his name has been mentioned in the *London Gazette* for distinguished services in action; and the order has never been conferred on an Officer below the rank of a Major, or Commander in the Navy.

BAT-HORSES.—Baggage horses or mules for carrying officers' baggage on service. The ammunition and regimental stores are also so carried when carts are not procurable.

BAT-MEN. — Originally servants hired in wartime to take care of the horses belonging to a train of artillery, battery, baggage, etc. Men who are excused regimental duty for the specific purpose of attending to the horses belonging to Officers are also called bat-men or bor-men.

BATON.—1. The figure in Heraldry commonly known as the bastard bar. It is variously written Battoon, Batune, and, in old French, Baston.—2. The name of a short staff presented by the Sovereign to each Field-marshal, as a symbol of his newly bestowed authority. It is also the name of the long staff carried by the Drum-major of a band. See *Bastard Bar* and *Drum-major*.

BATTA.—An Indian term implying field-allowances, which were granted formerly to troops in India in addition to their regimental pay; this was called full batta. Half-batta was half this allowance, and was paid to officers serving at the presidency towns, and within 200 miles of them—full batta being given to officers beyond that distance. There is no such distinction in name now as half and full batta in the pay of the officers, though in reality officers of the several Staff Corps in India only receive half-batta, the difference being made up in their allowances. Officers of British regiments receive full batta wherever they may be.

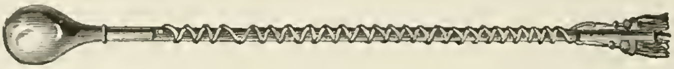
BATTALIA.—The order of battle; disposition or arrangement of troops, brigades, regiments, battalions, etc., as for action. Formerly the term applied to the main body of an army in array, as distinguished from the wings.

BATTALION.—A body of troops, so called from being originally a body of men arranged for battle. In the United States army, a regiment of infantry is composed of ten companies. A regiment, or any part of a regiment composed of two or more companies, is designated a *battalion.* For maneuvers the battalion is generally divided into an even number of companies, and the companies are equalized by transferring men from the larger to the smaller. Two companies constitute a *division.*

In each battalion there is a Color-guard, composed of a Color-sergeant and seven Corporals, which is posted as the left four of the right-center company. The front rank is composed of the Color-sergeant and three senior Corporals, one posted on his right and two on his left; the rear rank is composed of the four remaining Corporals. The Corporals are placed in the order of rank from right to left. The Color-sergeant and Color-corporals are selected from those most distinguished for bravery, and for precision under arms and in marching. The Color-sergeant carries the national color. The regimental color (when present) is carried by a Sergeant, who takes the place of the Corporal on the left of the Color-sergeant.

Posts of Field-officers and Regimental Staff.—The Field and Staff Officers are supposed to be mounted during all maneuvers; the Adjutant is on foot. The Senior Officer present commands the battalion. The *Colonel* is posted thirty yards in rear of the file-closers, opposite the center of the battalion. This distance is reduced as the front of the battalion is diminished. The *Lieutenant-colonel* and *Major* are on a line twelve yards in rear of the file-closers; the Lieutenant-colonel opposite the center of the right wing, the Major opposite the center of the left wing. The *Adjutant* and *Sergeant-major* are opposite the right and left of the battalion, six yards in rear of the file-closers. They aid the Lieutenant-colonel and Major respectively in their duties. At reviews, parades, and inspections, the *Adjutant* takes post three yards to the right of the front rank of the battalion; the *Sergeant-major* three yards to the left of the front rank. The *Surgeon, Quartermaster*, and other Staff-officers, in the order of rank from right to left, are on the left of the Colonel, and three yards in his rear. In column the Staff marches abreast of the center, on the flank opposite the guide, and at the same distance from the column as from the file-closers when in line. If the guide be changed, the Staff, unless otherwise directed, passes by the rear of the column to the opposite flank. In line, if the battalion wheels about by fours, the Staff, unless otherwise directed, passes around either flank to the new position in rear. In all battalion maneuvers, the Staff moves to its new position, in line or column, by the shortest practicable line, not passing between subdivisions. The *Quartermaster-sergeant, Commissary-sergeant*, and the *Hospital-steward* are in rear of the left-center company in the order of rank from right to left, three yards on the right, and in line with the front rank of the band. In all battalion maneuvers, the Non-commissioned Staff, except the Sergeant-major, conforms to the movements of the band.

Posts of the Band, and Trumpeters or Field-music.—The *band* is formed in two or more ranks, with sufficient interval between the files, and distances between the ranks, to permit a free use of the instruments. The *Trumpeters*, if not with their companies, form the rear of the band. When the band is not present, the post of the trumpeters and their movements are the same as prescribed for the band. In line, the band is habitually posted twelve yards in rear of the file-closers, the left opposite the left of the left-center company. At reviews, parades, and inspections, the band is posted on the right of the battalion, the left of its front rank twelve yards from the right of the front rank of the battalion. In column, except at review and inspection, the band is twelve yards from



Drum-Major's Baton.

the center of the column on the flank opposite the guide. If the guide be changed, the band, unless otherwise directed, passes by the rear of the column to the opposite flank. In line, if the battalion wheels about by fours, the band, unless otherwise directed, passes around either flank to its position in rear. In all battalion maneuvers, the band moves at quick or double time, by the shortest practicable line, to its position in line or in column; the march being so conducted as not to pass between the subdivisions, nor delay their march. When the signals for the Drum-major are not used, the band is maneuvered as explained for a squad, the command *band* being substituted for *squad*. When the battalion in column wheels about by fours, the band executes the countermarch; when the battalion executes the *right, left*, or *about face*, the band faces in the same manner. In marching, the different ranks of the band always dress to the right.

A battalion of Cavalry is usually composed of four companies, but may be composed of a less number, or a greater number not exceeding seven. The interval between companies in line is eight yards. In whatever direction the battalion faces, the companies are designated numerically from the right to the left in line, and from the head to the rear when in column, *first company, second company*, and so on. In whatever direction the battalion faces, the companies to the right of the center of the battalion in line constitute the *right wing;* those to the left of the center constitute the *left wing*. If there be an odd number of companies in line, the center company always belongs to the right wing.

Posts of Field-officers, Adjutant, and Sergeant-major.—The Senior Officer present commands the battalion, and in line is thirty yards in front of the center. If there be two Field-officers present, *the Junior*, in line, in line of platoon columns, and in line of double columns, is twelve yards in rear of the center of the battalion. If the battalion faces about, the Junior Field-officer passes by the shortest line to his place in rear. In column, the Junior Field-officer is twelve yards from the flank of the column, abreast of the center and on the side of the guide. In marching by the flank of subdivisions, he is twelve yards in rear of the center subdivision. In the maneuvers, the Junior Field-officer assists as the Commanding Officer may direct. *The Adjutant* is on the line of Chiefs of Platoon, and three yards outside of the right flank of the battalion. When the battalion faces about, the Adjutant wheels about and takes his place on the line of Chiefs of Platoon, but does not change to the other flank. *The Sergeant-major* is in line with the rank, three yards from the left flank. When the battalion faces about, the Sergeant-major wheels about, and takes his place at the prescribed interval from the rank, but does not change to the other flank.

A battalion of Artillery consists of any number of batteries from two to five. The interval between batteries in line is twenty-eight yards. In *horse-batteries* the interval is thirty-six yards. In whatever direction the battalion faces, the batteries are designated numerically from the right to the left in line, and from the head to the rear when in column, *first battery, second battery*, and so on. In whatever direction the battalion faces, the batteries to the right of the center of the battalion in line constitute the *right wing;* those to the left of the center constitute the *left wing*. If there be an odd number of batteries, the center battery always belongs to the right wing.

Posts of Major, Adjutant, Sergeant-major, and Trumpeter.—The *Major*, or Senior Officer present, commands the battalion, and in line is twenty-eight yards in front of the center. The *Adjutant* is in line with the Chiefs of Platoon, and three yards outside of the right flank of the battalion. When the battalion faces to the rear, the Adjutant executes an about and takes his place in line with the Chiefs of Platoon, but does not change to the other flank. The *Sergeant-major* is in line with the Chiefs of Platoon, three yards from the left flank. When the battalion faces to the rear the Sergeant-major executes an about, and takes his place in line with the Chiefs of Platoon, but does not change to the other flank. At review, other Staff-officers, in line, are on the right of the Adjutant; in column, they are in rear of the Major. On all other occasions they accompany the Major.

To Form the Battalion.

Infantry.—The companies being formed on their parade-grounds, *adjutant's call* is sounded, at which the Adjutant and Sergeant-major, the latter on the left, each covered by a Marker, march to the regimental parade-ground, where they post the Markers facing each other at a distance apart a little less than the front of a company; the Adjutant posts the Marker nearest the right of the line, the Sergeant-major the one nearest the left, each standing three yards in rear of the Marker nearest him; the Markers being assured, the Adjutant takes a side-step to the left, the Sergeant-major a side-step to the right, draw swords, and face about; the Adjutant then proceeds company distance toward the right of the line, the Sergeant-major company distance toward the left of the line, when they halt, face about, and again cover the Markers; the line is prolonged in the right wing by the Right Guides, who precede their companies on the line by fifteen or twenty yards, and establish themselves facing the Markers, each at company distance from the Marker or guide in front of him; the Adjutant assures the position of the Right Guides, placing himself in their rear as they successively arrive; the line is similarly prolonged in the left wing by the Left Guides, the Sergeant-major assuring them in their positions as they successively arrive. The Guides invert their pieces in front of the center of the body, barrel to the right, the right hand below the left, the small of the stock above the head. The color-company is the first established, and is conducted by its Captain so as to arrive from the rear, parallel to the line of Markers. When it arrives at three yards from the line, the Captain halts it, places himself facing to the front, near the left Marker, and then dresses the company to the left, the breasts of the men opposite the right and left Markers resting respectively against their left and right arms; the companies of the right wing form successively from left to right, each being halted at three yards from the line and dressed to the left as explained for the color-company; the Left Guide, at the command *halt*, returns to the line of file-closers; the companies of the left wing form successively from right to left, and are dressed to the right. In all alignments, the First-sergeants, if not employed to mark the line, step into the rear rank to enable the Captains to dress their companies. To enable the Captain of the company on the left of the color to align his company to the right, the Captain of the color-company steps a pace forward if he be the Senior, or into the rear rank if he be the Junior; if the Senior, he steps back into the front rank as soon as the Junior Captain commands *front;* the latter steps back to the rear rank; the First-sergeant of the left center company steps back to the line of file-closers. Each Captain commands: 1. (such) *Company*, 2. *Support*, 3. Arms, as soon as the Captain next succeeding him in his own wing commands *front;* the flank companies *support arms* as soon as dressed. Before sounding *adjutant's call*, the band takes a position designated by the Adjutant, and marches at the same time as the companies to its position in line. The Colonel takes post facing the line, at a distance in front of the center of the battalion, about equal to half its front. The Adjutant having assured the position of the Right Guide of the right company, faces about, marches three yards to the right of the front rank, faces to the left, moves two yards to the front, faces to the left and halts, and, when the last company arriving on the line is brought to *support arms*, commands: 1. *Guides*, 2. Posts. At the command *guides posts*, the Captains, Guides, and Markers take their posts in line; the First-sergeants, who are not employed to mark the line, step a pace to the rear to permit the Second-sergeants or Markers to pass through their intervals to the line of file-closers, after which they return to the front rank. *This rule is general.* The Adjutant then passes along the front in rear of the Captains, to the center, turns to the right, halts midway between the Captains and the Colonel, faces about, brings the battalion to a *carry*, and a *present arms*, resumes his front, salutes his Colonel, and reports: *Sir! The battalion is formed.* The Colonel returns the salute with the right hand, directs the Adjutant: *Take your post, Sir*, draws his sword and commands: 1. *Carry*, 2. Arms. The Adjutant faces about, and returns to his post, passing in rear of the Captains of the right wing around the right of the battalion.

Cavalry.—The companies being formed and mounted on their own grounds, *adjutant's call* is sounded, at which the Adjutant and Sergeant-major, the latter on the left, proceed to the battalion parade-ground, and post themselves facing each other, a few yards outside the points where the right and left of the right center company is to rest in line. The companies approach the line so as to arrive from the rear, and parallel to the line established by the Adjutant and Sergeant-major. The right-center company (or center company, if the number of companies be uneven) is first established on the line. As the right-center company approaches the line, its Principal Guides detach themselves, and, preceding the company by fifteen or twenty yards, place themselves between the Adjutant and Sergeant-major, facing each other, at a distance a little less than the front of the company. The Adjutant rectifies the position of the Right Principal Guide; the Sergeant-major rectifies the position of the Left Principal Guide. The Captain of the right-center company halts his company three yards from the line, places himself on the line, facing to the front, at the point where the left of his company will rest in line, and then dresses it to the left against the Principal Guides, so that the heads of the horses opposite the Principal Guides shall touch the boots of the Principal Guides. The other companies successively approach the line, in their order on the right and left of the right-center company. The Principal Guides of each company detach themselves as prescribed for the Guides of the right-center company, and hasten to place themselves on the line to be occupied by their respective companies; they face toward the Principal Guides already established, at a distance from each other a little less than the company front; the Principal Guide nearest those already established carefully preserves the interval of eight yards between companies. The Adjutant and Sergeant-major, having rectified the positions of the Principal Guides of the company which arrives first on the line, draw sabers; the Adjutant then wheels to the right about, moves toward the right, and again wheels to the right about, so as to place himself in rear of the Right Principal Guide of the company next on the right. The Sergeant-major wheels to the left about, moves toward the left, and wheels to the left about, so as to place himself in rear of the Left Principal Guide of the company next on the left. In this manner the Adjutant in the right wing, and Sergeant-major in the left wing, rectify in succession the positions of the Guides of each company; they then take their places in line. Each Captain halts and dresses his company as prescribed for the right-center company, each company being dressed toward the company first established. The line being formed, the Adjutant advances three yards from his position on the right, wheels to the left, halts, and commands: 1. *Guides*, 2. Posts, at which the Captains and Principal Guides return to their posts in line. The Major takes post facing the line, at a convenient distance in front of the center of the battalion, generally equal to about half its front. The Adjutant then passes in front of the officers to the center, wheels to the right, and halts midway between the Major and the line, wheels to the left about, commands: 1. Draw, 2. Saber, 3. *Present*, 4. Saber, wheels to the left about, salutes the Major and reports: *Sir! The battalion is formed.* The Major returns the salute with the right hand, directs the Adjutant: *Take your post, Sir*, draws his saber, and commands: 1. *Carry*, 2. Saber. The Adjutant wheels to the left about, moves toward the line, wheels to the left, and, passing in front of the officers, takes his place on the right.

Artillery.—The batteries being formed at their own parks, *adjutant's call* is sounded, at which the Adjutant and Sergeant-major, the latter on the left, proceed to the battalion parade-ground, and post themselves facing each other, a few yards outside the points where the right and left of the right-center battery is to rest in line. The batteries approach the line so as to arrive from the rear, and parallel to the line established by the Adjutant and Sergeant-major; the right-center battery (or center battery, if the number of batteries be uneven) is first established on the line. As the right center battery approaches the line, the First-sergeant and Guidon, who are called *Principal Guides*, detach themselves, precede the battery by fifteen or twenty yards, and place themselves between the Adjutant and Sergeant-major, facing each other, at a distance apart a little less than the front of the battery; the Adjutant rectifies the position of the First-sergeant; the Sergeant-major that of the Guidon. The Captain of the right-center battery halts it at three yards from the line and dresses it to the left as prescribed in the School of the Battery, so that the heads of the lead-horses of the leading carriages of the right and left sections shall be in line with the boots of the Principal Guides. The other batteries successively approach the line on the right and left of the right-center battery. The Principal Guides of the other batteries detach themselves as prescribed for the guides of the right-center battery, and hasten to place themselves on the line to be occupied by their respective batteries; they face toward the Principal Guides already established, at a distance from each other a little less than the battery front; the Principal Guide nearest those already established carefully preserves the interval of twenty-eight yards between the batteries. The Adjutant and Sergeant-major, having rectified the positions of the Principal Guides of the battery which arrives first on the line, draw saber; the Adjutant then executes a right about, moves toward the right, and again executes a right about, so as to place himself in rear of the Right Principal Guide of the battery next on the right; the Sergeant-major executes a left about, moves toward the left, and executes a left about, so as to place himself in rear of the Left Principal Guide of the battery next on the left. In this manner the Adjutant in the right wing, and the Sergeant-major in the left wing, rectify in succession the positions of the guides of each battery; they then take their posts in line. Each Captain halts and dresses his battery as prescribed for the right-center battery; each battery is dressed toward the right-center battery. The line being formed, the Adjutant advances three yards from his post on the right, wheels to the left, halts, and commands: 1. *Guides*, 2. Posts, at which the Captains and Principal Guides return to their posts in line. The Major takes post facing the line, at a convenient distance in front of the center of the battalion, generally equal to about half its front; the Adjutant then passes in rear of the Captains to the center, wheels to the right, and halts half-way between the Major and the line, executes a left about, commands: 1. *Present*, 2. Saber, executes a left about, salutes the Major, and reports: *Sir! The battalion is formed.* The Major returns the salute with the right hand, directs the Adjutant: *Take* *your post, Sir,* draws saber, and commands: 1. *Carry,* 2. SABER. The Adjutant executes a left about, moves toward the line, wheels to the left, and, passing in rear of the Captains, takes his post on the right. See *Inspection of Troops, Muster,* and *Review.*

BATTARD.—An early cannon of small size, now obsolete. See *Cannon.*

BATTEN.—1. The sloping of a wall which brings the perpendicular from the top inside the base.—2. A species of sawn fir timber, of smaller dimensions than the kind called planks. Battens are usually from 12 to 14 feet long, 7 inches broad, and 2½ inches thick. Cut into two boards (1¼ inches thick), they are used for flooring; cut into three boards, they are put on roofs below slates; in narrower pieces, they are put upright on walls for fixing the laths for plastering. The best battens are brought from Norway, and sold wholesale by wood-merchants.

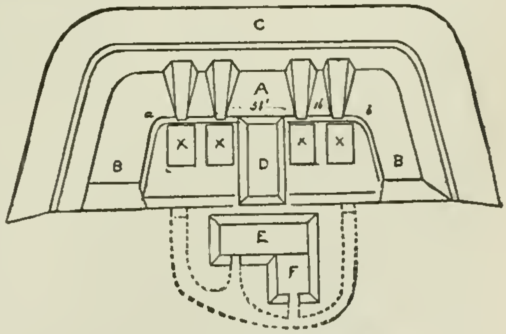
BATTER.—1. A cannonade of heavy ordnance, from the first or second parallel of an intrenchment, against a fortress or other works. To batter *in breach* implies a heavy cannonade of many pieces directed to one part of the revetment from the third parallel.—2. In fortification, the backward slope of a revetment or retaining wall. The drawings show the batter-slopes adopted by Engineers at the present time. These slopes are 1 in 4, 1 in 5, 1 in 6, 1 in 8, 1 in 10, and 1 in 12.

BATTERIE EN ROUAGE.—An enfilading battery, when directed against another battery.

BATTERIES.—A battery consists of two or more pieces of artillery in the field. The term *battery* also implies the emplacement of ordnance destined to act offensively or defensively. It also refers to the company charged with a certain number of pieces of ordnance. The ordnance constitutes the battery. Men serve the battery. Horses drag it, and epaulments may shelter it. A battery may be with or without embrasures. In the latter case it is *en barbette,* and the height of the *genouillère* varies according to the description of the gun-carriage used. The ordnance constituting the battery requires substantial bearings either of solid ground for field-pieces, or of timber, plank, or masonry platforms, for heavy artillery. Batteries are sometimes designated as follows: *Barbette battery,* one without embrasures, in which the guns are raised to fire over the parapet; *Ambulant battery,* heavy guns mounted on traveling carriages, and moved as occasion may require, either to positions on a coast, or in besieged places; *Covered battery,* intended for a vertical fire, and concealed from the enemy; *Breaching battery; Joint batteries,* uniting their fire against any object; *Counter battery,* one battery opposed against another; *Coast battery; Direct battery; Cross batteries,* forming a cross fire on an object; *Oblique battery,* forming an angle of 20° or more with the object against which it is directed, contradistinguished from direct battery; *Raised battery,* one whose terre-plein is elevated considerably above the ground; *Sunken-battery,* where the sole of the embrasures is on a level with the ground, and the platforms are consequently sunk below it; *Enfilading battery,* when the shot or shell sweeps the whole length of a line of troops or part of a work; *Horizontal battery,* when the terre-plein is that of the natural level of the ground, consequently the parapet alone is raised and the ditch sunk; *Open battery,* without epaulment or other covering, wholly exposed; *Indented battery,* or battery *à crémaillère,* battery constructed with salient and re-entering angles for obtaining an oblique as well as a direct fire, and to afford shelter from the enfilade fire of the enemy; *Reverse battery,* that which fires upon the rear of a work or line of troops; *Ricochet battery,* whose projectiles, being fired at low angles, graze and bound without being buried; *Masked battery,* artificially concealed until required to open upon the enemy.

Field-batteries, in sieges, are usually of two kinds, viz., Elevated batteries and Sunken batteries, and they are placed either in front of the parallel, in the parallel itself, or in rear of it. In an elevated battery, the platforms for the guns or mortars to stand upon are laid on the natural level of the ground, and the whole of the covering mass, or parapet, is raised above that level, the earth for forming it being obtained from a ditch in front. In a sunken battery, the whole interior of the battery is excavated about three feet deep, and the platforms laid on the bottom, the earth is thrown to the front, and the parapet is formed out of it. Great care must be taken that no rise in the ground before the battery obscures the view from the soles of the embrasures; for this purpose, the officer laying out the battery should lie down and look along the ground, in order to be sure that his guns can range freely from their embrasures, before he fixes his details for construction. When guns are fired with an elevation, when the soil is sandy or gravelly, when the weather is dry, or the ground elevated, this construction is approved. The depth of the excavation for the interior must depend on the height of the carriages upon which the guns are mounted: it should be deeper in rear than in front, that it may be drained. The interior slopes of these batteries, and the cheeks of the embrasures, must be supported by field-revetments of gabions, fascines, sand-bags, casks, or sods. In batteries exposed to a heavy fire, especially of shells, it is necessary to provide as much cover as possible for the men serving in them; for this purpose, traverses are usually placed between every two guns; and as these masses serve to protect the men from the splinters of the bursting shells, they are generally called splinter-proof traverses. There is nearly twice as much work in the elevated as in the sunken battery.

A battery for four siege-pieces is represented in the drawing. In this construction, the parapet (A) is



Battery for Four Siege-Pieces.

made of earth taken from the front, thus forming a ditch (C). To protect the pieces (× × × ×) from flank fire, the parapet is continued around on one or both ends, forming epaulments (B B). The guns are in pairs, separated by a traverse (D). The interval between the axes of the embrasures of each pair is 16 feet for guns on traveling carriages, and from 18 to 22 feet for sea-coast guns. Between the two middle pieces this distance is increased by the thickness of the traverse, generally about 15 feet. The entire length of the interior crest of the parapet, from *a* to *b,* will therefore be 79 feet. This and other given dimensions are not absolute, but indicate the method of obtaining the data necessary for laying out *any* battery. The length of the flank epaulments will depend upon the direction of the enemy's fire; in all cases it must be sufficiently great to give full protection to the whole interior from an enfilading fire;

generally it would be about 24 feet. The thickness of the parapet and epaulments will depend upon the power of the artillery they are expected to resist.

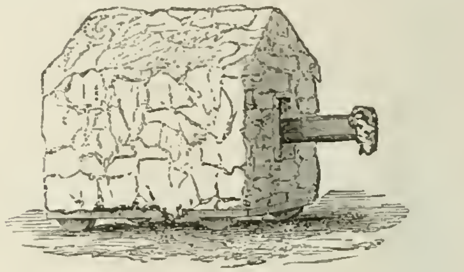
Batteries for even the heaviest pieces may be constructed on marshy ground by laying a grillage of timber over the surface and building up the parapet on it with sand-bags. To prevent the parapet from settling over towards the front, the grillage should extend several feet beyond it in that direction. In order that the platform of the piece may not be moved from its true horizontal position by any settling of the parapet, the space to be occupied by it is inclosed with strong sheeting piles. In this inclosed space several layers of fascines are laid, crossing each other at right angles; on these earth or sand is rammed, and the platform laid in the usual manner. If sand is used on top of the fascines, two or three thicknesses of paulins should be spread over them to hold the sand. Magazines in such localities must, of necessity, be entirely above ground, and supported on grillage in the same manner. See *Embrasure*.

BATTERING CHARGES.—In the service of artillery there are two classes of cartridges, *battering* and *full*. The first is used with Palliser projectiles, and only under certain circumstances with common shell; the second is the ordinary charge used with common, double, shrapnel shell, and case-shot. The powder used would be pebble for all battering charges, and for full charges of 40 pounds and upwards.

The reason why pebble-powder is now used with all large guns instead of ordinary powder is explained as follows: that the pressure on the gun is much less, and the velocity greater, with the former than the latter. This increased velocity is due to the lower pressure of the powder, which is kept up longer in the bore than with quicker-burning powder, the velocity depending upon the pressure and the space over which it is exerted.

BATTERING PROJECTILES.—Projectiles for battering purposes are made of cast-iron, chilled iron, and steel. Against parapets of earth common shell containing large bursting-charges are the most effective. Compound shot, having chilled cast-iron heads and cast-steel bodies, give good results, but they lack the power to carry their bursting-charge behind the armor which they can penetrate. The hardness and tenacity of steel shot and shell make them very effective against all kinds of armor. Their great cost prevents their use when good results can be accomplished by chilled shot. Gunpowder is not a sufficiently powerful explosive for these strong shells, and, moreover, it explodes on impact. Satisfactory experiments have been made with bursting-charges of gun-cotton, which only explodes when the penetration is complete. Both forged and cast steel shells, well tempered, have perforated great thicknesses of wrought iron, in direct hitting, without being injured. Cast-steel projectiles, compressed by an hydraulic press while in a fluid state to drive out bubbles, give excellent results. In direct fire against steel-faced armor, cast-steel shells, owing to their great hardness, behave better than those of forged steel. The reverse is the case in oblique fire, where tenacity and toughness are the main considerations. All steel projectiles thus far tried break up against steel-faced armor in oblique fire. The longer the head of the projectile the greater the effect in direct fire, while for oblique fire the best effects are obtained with heads struck with a radius of two diameters. The flat-headed projectiles are much inferior to those with pointed heads in both direct and oblique fire. The respective advantages of light and heavy shells may be said to be as follows, assuming the powder-charge to be constant: The heavier shells, though starting with a lower initial velocity, keep up their velocity better than lighter ones, and so have a longer range of penetrative effect. The lighter shells have a higher velocity at short ranges, and a flatter trajectory; also, a greater number can be carried for a given weight. The projectile must not be so heavy as to strain the gun unduly, but this is easily avoided by the use of slow-burning powder and air-spacing. The cavity in shells should be as capacious as possible, so as to carry a large bursting-charge, but this will be controlled by the thickness which the head and walls must possess to give the necessary strength. See *Armor-plates*.

BATTERING-RAM.—An engine of war used in ancient times and in the Middle Ages. It consisted of a beam of wood with a mass of bronze or iron on one end, resembling the head of a *ram*. In its simplest form it was borne and impelled by the hands of the soldiers; afterwards it was suspended in a frame, and made to swing. Another form moved on rollers.



Battering-ram.

The alternating motion was communicated by ropes. To protect those working it, a wooden roof (*testudo*) was constructed over it, and the whole was mounted on wheels. The beam of the ram varied from 60 to 120 feet in length, the head sometimes weighed above a ton, and as many as 100 men were employed in impelling the machine. When the blows were long enough continued, hardly any wall could resist. When or where it was invented is unknown. It is mentioned by Ezekiel. The Romans derived it from the Greeks.

BATTERING-TRAIN.—A train of artillery used solely for besieging a strong place, inclusive of mortars and howitzers. See *Siege-train*.

BATTERY-BOXES.—Square chests or boxes, filled with earth and used in making batteries where gabions are not to be had.

BATTERY-GUN.—A gun having a capacity for firing a number of shots consecutively or simultaneously without stopping to reload. There are many varieties.

1. A piece of ordnance having a number of load-chambers attached to a vertical axis, and consecutively presented at the rear of the cannon-bore. As each takes its place at the breach, it is advanced into the bore and locked before firing.

2. A chambered breech-piece, revolving in a vertical plane, and presenting its chambers consecutively at the open rear of the barrel, which is common to all the chambers. The principle of construction is that of the revolving chambered pistol.

3. A number of parallel barrels arranged in rank, and having connected vents for intercommunication of fire. The infernal-machine of Fieschi, which he fired on Louis Philippe, was a row of barrels clinched to a frame, and had a train of powder which was laid over all the vents in succession, like the row of barrels in a proving-house.

The Requa battery consists of 25 rifles, each 24 inches long, mounted in a horizontal plane upon a field-carriage. It is breech-loading, the cartridges being forced into the chambers by a sliding-bar worked by two levers. By a lever beneath the frame the barrels may be diverged, so as to scatter the balls 120 yards in a distance of 1000 yards. The weight of the battery-gun used at Charleston, S. C., was 1382 pounds. Served by three men, it fired seven volleys, or 175 shots, per minute. Its effective range was 1300 yards.

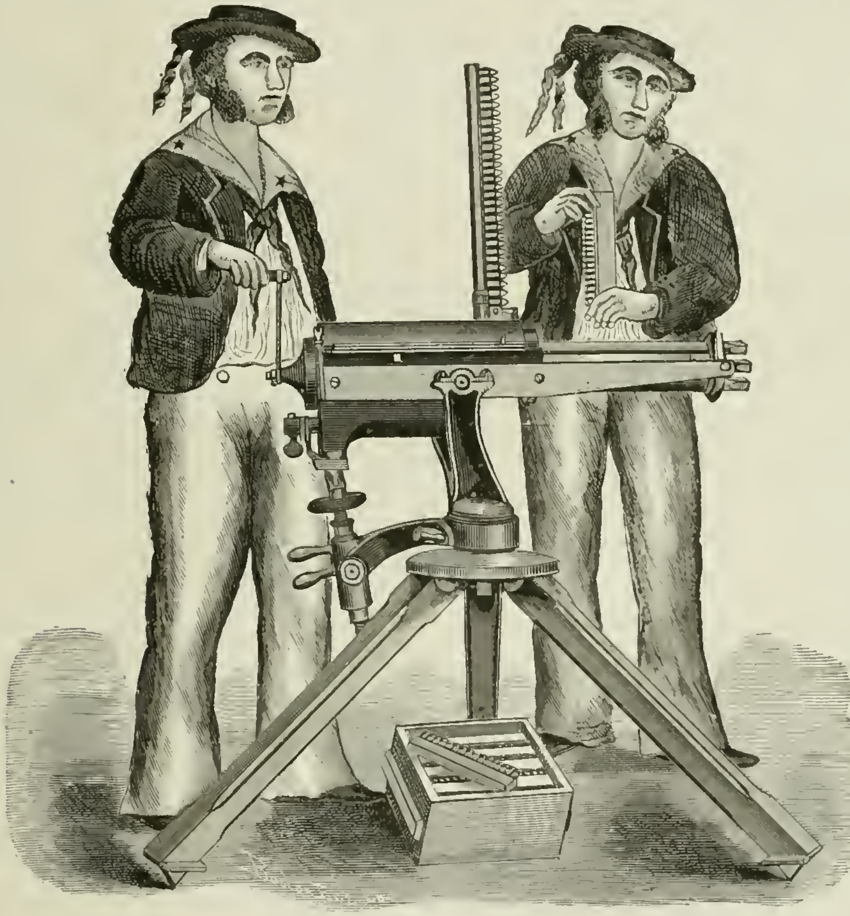
4. Forms of many-barreled cannon revolving on a vertical axis, the pieces being muzzle-loaded.

5. A cluster of rotating barrels, consecutively loaded and fired by automatic action.

6. A cluster of barrels, in whose rear is placed a chambered plate, each of whose chambers corresponds to one of the clusters of barrels, against whose rear it is locked before firing.

7. A number of chambered blocks brought consecutively to the positions for loading, and then for firing, through a group of barrels equal in number to the number of chambers.

The drawing shows the Lowell battery-gun, mounted on a tripod, and ready for firing. A brief notice of its action will suggest the requisite features of all battery-guns. The feed comprises the feeding-tube and carrier-rolls; the former keeping each cartridge horizontal till it is received by the latter. A double extractor, grasping as it does the butt of the cartridge on both sides, works with very great certainty. This certainty is not only due to the fact of its being double, but also to the fact of the extractors not depending on their spring or elasticity, but to a positive movement being given to their hooks by a shoulder on the lock-plunger, working on the curved portion of their rear ends. Thus the extracting hooks are obliged to retain hold of the flange of the cartridge until entirely extracted, when the empty shell is readily removed from the hooks by the carrier-rolls. The working parts being exposed by simply turning back their cover, allows the mechanism to be at once seen and readily removed; and whenever a stoppage may occur, its cause is *immediately seen* and easily remedied. The shape of the cam which operates the lock is such that after the plunger has shoved the cartridge into the barrel, and it has been fired, it continues to be supported in rear by the cam during a portion of its revolution. This arrangement is of great value in a machine-gun, where the cartridges are entered and extracted from the barrel with such rapidity that hang-fires are liable to occur. The gun, firing as it does all its shots from one barrel at a time, compares in this respect very favorably indeed with any machine-gun. Twice during a recent trial three hundred shots were fired considerably within a minute, the actual time being fifty-three and fifty-four seconds respectively. It is proposed by the inventor to construct a gun with double the number of barrels, making eight, with two locks, so that a fire of four or five hundred shots a minute can be steadily maintained without being obliged to give a too rapid motion to the crank. The question of rapidity of fire being well established for all well-known machine-guns, it seems that the points to which attention should now be given in the trial of a machine-gun are simplicity of mechanism, liability to get out of order, and accessibility of parts. In these are included the feed and extracting, also durability. These points have been highly developed in the gun before us, and its mechanism brought to a fair state of perfection. See *Gardner Machine-gun*, *Gatling Gun*, *Hotchkiss Revolving Cannon*, *Lowell Battery-gun*, *Nordenfelt Gun*, and *Taylor Gun*.



Lowell Battery-gun, mounted on Tripod.

BATTERY-WAGON.—A wagon designed to accompany a field-battery, for the purpose of transporting carriage-maker's and saddler's tools, spare parts of carriages, harness, and equipments, and rough materials for replacing different parts. It is made of equal mobility with other field-carriages, in order to accompany them wherever they may be required to go. The following are the supplies usually carried in the battery-wagon and forge for a battery of six guns:

Contents of Limber-Chest. (Smith's tools and stores.)	No.	Weight Lbs.	Place.
Horseshoes, Nos. 2, 3....lbs.	100	100.00	Box A 1.
Horseshoes, Nos. 2, 3....lbs.	100	100.00	Box A 3.
Horseshoe-nails, Nos. 2 and 3.........lbs.	50	50.00	Box A 2, large division.
Washers and nuts, No. 2....	30	5.25	In box A 2, 91.11 lbs.
Washers and nuts, No. 3....	10	3.20	
Washers and nuts, No. 4....	4	2.15	
Nails, No. 1, C............lbs.	1	1.00	
Nails, No. 2, C............lbs.	1	1.00	
Tire-bolts..............	10	5.00	
Keys for ammunition-chests	5	1.80	
Linch-washers (caisson).....	8	7.30	
Linch-pins (caisson).........	12	8.37	
Linch-pins (for piece)........	6		
Chains, Nos. 1 and 2.....feet	2	1.54	
Cold-shut S links, No. 3......	50	2.50	
Cold-shut S links, No. 5......	12	2.00	
Hand cold-chisels...........	2	2.00	In box A 4, 28.52 lbs.
Hardie	1	0.75	
Files, assorted, with handles	12	10.00	
Buttress	1	1.50	
Hand-punches, round and square	2	2.00	
Screw-wrench	1	2.42	
Hand screw-driver	1	0.32	
Hand vise	1	1.00	
Smith's calipers, pair	1	0.40	
Taps....... Nos. 1, 2, 3, 4...	4	1.50	
Dies, pairs Nos. 1, 2, 3, 4...	4	1.83	
Wood screws, 1', No. 14..gr.	1	2.10	
Quart can of sperm-oil.......	1	2.70	
Borax.....................lbs	2		
Fire-shovel	1	3.05	In box A 5, 80.05 lbs.
Poker......................	1	1.90	
Split broom................	1	1.25	
Hand-hammers..............	2	6.50	
Riveting-hammer...........	1	1.05	
Nailing-hammer............	1	1.80	
Sledge-hammer.............	1	10.50	
Chisels for hot iron..........	2	3.00	
Chisels for cold iron.........	2	3.00	
Smith's tongs..............	3	15.00	
Fore-punch.................	1	1.00	
Creaser....................	1	1.00	
Fuller	1	2.40	
Nail-claw..................	1	5.00	In box A 5, 80.05 lbs.
Round-punch...............	1	2.10	
Tap-wrench................	1	3.75	
Die-stock	1	6.25	
Nave-bands, developed......	4	11.75	
Tire-bands, developed......	2	2.75	
Shoeing-hammer............	1	0.82	In shoeing-box, 12.75 lbs.
Pincers, pair.............	1	2.00	
Rasps (12 inches)	2	2.15	
Shoeing-knife	1	0.33	
Toe-knife..................	1	0.30	
Pritchel...................	1	0.85	
Nail-punch	1	0.80	
Clinching-pin..............	2	1.00	
Oil-stone..................	1	1.50	
Leather aprons.............	2	3.00	
Horse-tail brush............	1	1.00	
Iron square................	1	2.00	Fastened on inside of chest-cover with two copper clamps.
Padlock...................	1	0.50	On the chest.
Tar-bucket	1	7.00	On its hook.
Boxes.....................	6	53.45	
Tow for packing............	..	5.00	
Total	.....	484.38	

One pound of horseshoe-nails, No. 3, contains 140 nails; one pound of horseshoe-nails, No. 2, contains 112 nails; one hundred pounds of horseshoes contain 90 shoes.

Contents of Forge-Body.

Tools and Stores.	No.	Weight Lbs.	Place.
Square iron, ½ in. and 1 in..	..	100	In the iron-room. Bars not more than 3 ft. long. Square iron in two bundles.
Flat iron, 1¼ × ⅝ in., 1 × ½ in., 1¼ × 1½ × ¼ in......	..	50	
Round iron, ⅜ in...........	..	50	
Cast-steel, ½ in. square.....	..	10	
English blistered steel.......	..	5	
Boxes 5 and 6, containing:			
Horseshoes, Nos. 2 and 3....	..	200	In iron-room.
Horseshoe-nails, Nos. 2 and 3	..	20	
Water-bucket............	1	10	On its hook.
Watering-bucket (leather)...	1	8	On the vise.

Tools and Stores.	No.	Weight Lbs.	Place.
Anvil	1	100	On the fireplace.
Vise	1	29	On stock of forge.
Bituminous coal............	..	250	In the coal-box.
Coal-shovel................	1	5	
Padlock....................	1	...	On coal-box.
Tow.......................	..	5	
Total	.....	842	

The anvil-block is carried on the hearth of the forge, and secured by having a hole through its axis, through which is passed a lashing-rope.

Contents of Limber-Chest.

Tools and Stores.	No.	Weight Lbs.	Place.
Carriage-maker's Tools.			
Hand-saw...................	2	4.00	Fastened to the inside of chest-cover.
Tenon-saw (14 in.)	1	1.50	
Jack-plane..................	1	4.15	In box C 1, 17.20 lbs.
Smoothing-plane............	1	1.80	
Brace, with 24 bits	1	4.35	
Spokeshave.................	1	0.30	
Gauge......................	1	0.30	
Plane-irons.................	2	1.05	
Saw-set....................	1	0.25	
Rule (2 feet)...............	1	0.14	
Gimlets....................	12	0.95	
Compasses, pair............	1	0.18	
Chalk-line..................	1	0.10	
Brad-awls..................	2	0.17	
Scriber....................	1	0.15	
Saw-files (4½ in)............	12	0.87	
Wood-files (10 in.)	2	1.12	
Wood-rasp (10 in.)..........	1	0.40	In box C 2, 32.23 lbs.
Trying-square (8 in.).........	1	0.60	
Hand screw-driver...........	1	0.32	
Oil-stone...................	1	1.50	
Broad-axe..................	1	6.00	
Hand-axe...................	1	5.00	
Claw-hatchet...............	1	2.00	
Claw-hammer	1	1.50	
Pincers (small), pair	1	1.06	
Table-vise	1	3.80	
Framing-chisels (1 and 2 in.)	2	3.00	
Firmer-chisels (¾ and 1½ in.)	2	1.00	
Framing-gouges(1 and 1½in.)	2	2.60	
Augers and handles (½, ⅝, ¾, 1, and 2 in.)........	5	4.50	In box C 3, 23.25 lbs.
Screw-wrench	1	2.42	
Felling-axe with handles...	1	6.00	
Adze...... with handles...	1	3.30	
Frame-saw..................	1	4.50	
Quart can of sperm oil......	1	2.70	
Compass-saw...............	1	....	
Tacks (carpenters').......M.	5	5.00	
Measuring-tape.............	1	....	
Chalk.....................	..	2.00	
Saddler's tools and stores.			
Mallet.....................	1	1.75	
Clam......................	1	5.00	
Hammer	1	0.65	In box C 4.
Shoe-knives	2	0.20	
Half-round knive...........	1	0.28	
Shears, pair................	1	0.47	
Sandstones.................	2	0.30	
Rule (2 feet)	1	....	
Needles, assorted..........	100	....	
Collar-needles.............	5	....	
Thimbles	4	....	
Awls......................	36	0.50	
Awl-handles................	6	0.75	
Punches, assorted..........	6	1.00	
Pincers, pairs.............	3	6.75	
Pliers, pairs..............	6	....	
Claw-tools	2	....	
Creasers..................	1	....	
Gauge-knife...............	1	0.75	
Scissors, pair.............	1	....	
Compass, pair.............	1	0.25	
Strap-awls................	3	....	
Saddler's mallet...........	1	1.75	
Saddler's clam............	1	5.00	
Bristles...................	..	2.00	
Saddler's thread..........	..	2.00	
Bees-wax..................	..	3.00	
Black-wax.................	..	5.00	
Patent thread	..	5.00	
Shoe-thread ....lbs.	..	2.00	
Buckles, assorted (0.75 to 1.5 in.)...................doz.	3	1.00	
Tacks (iron and copper), assorted...................	..	10.00	
Hand-saws................	2	2.00	
Tenon-saws...............	2	....	
Blades for frame-saws	4	....	
Total.....................	.....	173.00	

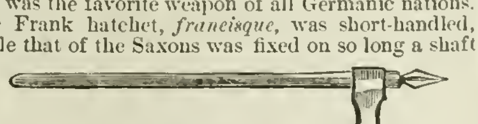
Contents of Wagon-Body.

Tools and Stores.	No.	Weight Lbs.	Place.
Grindstone, 14 × 4 in.	1	60	
Arbor and crank for do.	1		
Pintles (for piece)	1	35	
Horse-collars (assorted)	10	45	
Girths	20	12	
Lead-traces	15	75	
Whips (artillery)	5	2	
Wheel-traces	10	48	
Currycombs	15	12	
Horse-brushes	15	12	
Nose-bags	10	11	
Saddle-blankets	20	60	
Spurs and straps .... pairs	5	5	
Halters and straps	20	65	
Watering-bridles	10	12	
Bridles (artillery)	6	18	
Hame-straps	40	8	
Harness-leather .... sides	2	50	
Bridle-leather .... sides	3	33	
Sash-cord .... pieces	6	10	
Pole-yoke	1	13	
Elevating-screw	1	32	
Saw, cross-cut (6 feet)	1	12	
Rope-trace .... feet	200	..	On the march these are carried on a caisson.
Block (treble) for above	1	..	
Block (double) for above	1	..	
Watering-buckets	5	40	
Fuse-wrenches	3	..	In box C 6.
Fuse-gauges	3	..	
Fuse-knives	3	..	
Fuse-reamers	3	..	
Gunner's pincers	3	.	
Vent-punches	3	..	
Breech-sights	3	..	
Priming-wires	12	..	
Gunner's gimlets	6	..	
Primer-pouches	3	..	
Castile soap	..	10	
Handspikes	3	36	
Tallow	..	30	
Staves—sponge and rammer (lashed to wagon outside)	3	11	
Neat's-foot oil .... gal.	6	50	
Grease, wheel (1-lb. cans)	..	70	
Nails (4-, 6-, 8-, and 10-penny)	..	20	
Claw-hatchet	1	2	
Spirit-level (carpenter's)	1	..	
Sperm or wax candles	..	5	
Rammer-beads	6	5	
Sponge-heads	3	5	
Sponges	12	3	
Sponge-covers	6	..	
Lanyards (for fric'n-primers)	6	..	
Dark-lanterns	3	3	
Common lanterns	4	4.60	
Total	.....	1100	

The battery-wagon here mentioned is that furnished from the arsenals; but, being cumbersome and quite unsuitable for field-service, it is better to utilize its body and limber-chest by placing them on the running-gear of the army transportation-wagon. The limber-chest can be attached to the front part of the wagon-body by strong iron brackets, and serves as a seat for the driver. A similar chest can be placed, in like manner, on the rear end in place of the forage-rack. In the front chest is carried the carriage-maker's outfit, and in the rear one that of the saddler. See *Traveling Forge.*

BATTLE-ARRAY.—Array or order of battle; the disposition of forces preparatory to a battle.

BATTLE-AXE.—A cuneiform weapon, like the common hatchet, from which it is modified. It was best known in the so-called ages of stone and bronze, and was the favorite weapon of all Germanic nations. The Frank hatchet, *franeisque*, was short-handled, while that of the Saxons was fixed on so long a shaft



Battle-axes.

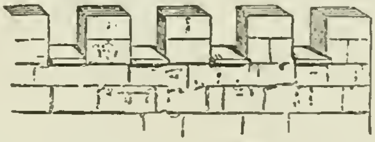
that among the Anglo-Saxons it was named pole-axe. The foot-soldier's battle-axe of the fourteenth century differs considerably from the weapon of an earlier date. Though on one side an axe, it becomes on the other a war-hammer, either with a saw-edge or a sharp point, but generally large and curved, called *falcon-beaked;* whilst the term *parrot-beaked* was applied when the weapon was short in the handle and belonged to a horseman. In this last form it is frequently found to have a gun-barrel encased in the handle, either the primitive hand-cannon or the wheel lock pistol. A long dart or sword is sometimes fixed at the top of the battle-axe.

BATTLE-GROUND CEMETERIES.—In order to secure, as far as possible, the decent interment of those who may fall in battle, it is made the duty of Commanding Generals to lay off lots of ground in some suitable spot near every battle-field, so soon as it may be in their power, and to cause the remains of those killed to be interred, with head-boards to the graves bearing numbers, and, where practicable, the names of the persons buried in them. A register of each burial-ground is preserved, in which are noted the marks corresponding with the head-boards. See *National Cemeteries, Post Cemeteries,* and *Superintendent of National Cemeteries.*

BATTLEMENTS.—Notched or indented parapets used in fortifications. The rising parts are called cops or merlons; the spaces by which they are sepa-

Early English Traceried Battlement.

rated, *crenels*, embrasures, and sometimes loops. The object of the device is to enable the soldier to shelter himself behind the merlon, whilst he shoots through



Simple Form of Battlement.

the embrasure. The bass-reliefs of Nineveh, and the Egyptian paintings, testify to its antiquity, and there is perhaps no nation by which it has not been adopted.

BATTLE-PIECES.—Paintings representing battles. The modern mode of warfare is less favorable for this branch of art than the ancient, where personal valor had more room to display itself. Among the greatest paintings of this kind are the Battle of Constantine, sketched by Raphael and executed by Giulio Romano; Lebrun's Battles of Alexander; and the Battle of the Amazons by Rubens. In smaller scenes, such as skirmishes and surprises, Antonio Tempesta, Hans Snelink, Pet. Snyders, Fulcone, Phil. Wouverman, etc., are distinguished. The most eminent of recent battle-painters is Horace Vernet.

BATTLE-RANGE.—The range corresponding to the maximum "dangerous space" for the trajectory of any fire-arm. This range is somewhat greater for such fire-arm employed against mounted troops than against foot-troops. See *Dangerous Space.*

BATTLES.—General actions in which all of the divisions of an army are or may be engaged. Considered in their political relations, the importance of battles is not always in proportion to their magnitude. There are some battles which claim our attention, independently of the moral worth of the combatants, on account of their enduring importance, and by reason of their practical influence on our own social and political condition, which we can trace up to the results of those engagements. They have for us an actual and abiding interest, both while we investigate the chain of causes and effects, by which they have helped to make us what we are; and also while we speculate on what we probably should have been if any one of those battles had come to a different termination. The fifteen battles which, in Professor Creasy's opinion, have had the most decisive influence are the following:

B.C.
490. Battle of Marathon.
413. Defeat of the Athenians at Syracuse.
331. Battle of Arbela.
207. " " the Metaurus.

A.D.
9. Defeat of the Romans under Varus.
451. Battle of Chalons.
732. " " Tours.
1066. Battle of Hastings.
1429. Joan of Arc's victory at Orleans.
1588. Defeat of the Spanish Armada.
1704. Battle of Blenheim.
1709. " " Pultowa.
1777. Defeat of Burgoyne at Saratoga.
1792. Battle of Valmy.
1815. " " Waterloo.

Battles, though planned and fought almost solely on tactical principles, have in many cases important strategical bearings which it is the province of an able General to see and to take advantage of. Skillfully combined strategical marches, when ably executed, may alone decide the fate of a campaign, without the necessity of coming into collision with the enemy; but this is a rare case, and a battle is usually the necessary sequence to an important strategical movement, and, if well planned and successfully fought, may prove decisive of the war.

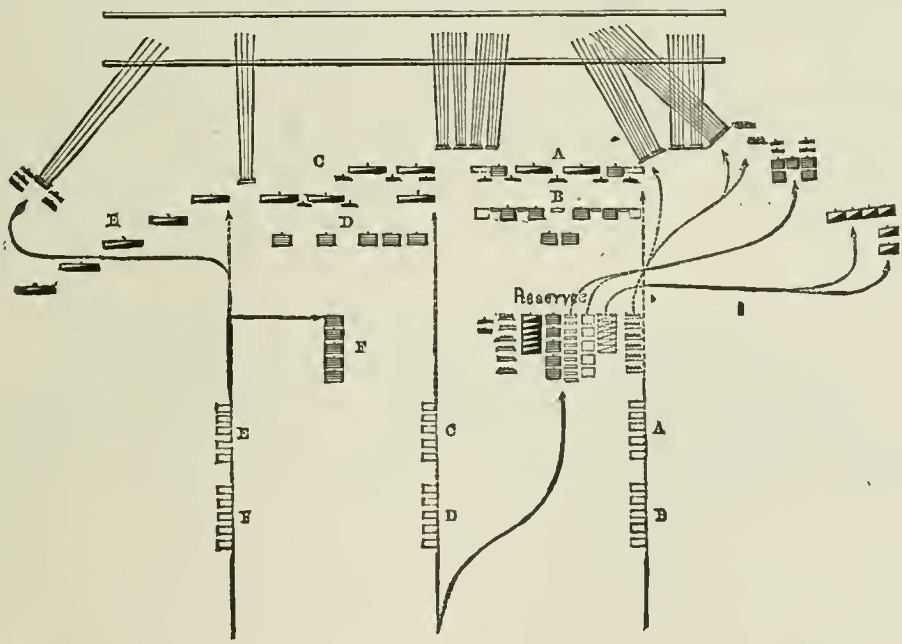
Military writers designate by *orders of battle* the general combinations made to attack one or more points of an enemy's position; whilst they apply the term *line of battle* to the disposition of the troops, in their relations to each other for mutual co-operation, acting either offensively or defensively. Whatever may be the disposition of the troops, the line of battle of any considerable force will present a well-defined center and two wings; thus offering to an assailant one or more of these as his point of attack. This has led to dividing orders of battle into several classes, arising from the necessary disposition of the assailing force, as it moves to attack one or more of these points. If an equal effort is made to assail every point of the enemy's line, the assailing force must necessarily advance on a line parallel to the one assailed, and this therefore has received the name of the *parallel order of battle*. If the line of the assailing force is sensibly perpendicular to that of the assailed, the disposition is said to be the *perpendicular order*. If the main attack is made by one wing, the center and other wing being held back, or *refused* as it is termed, the positions of the lines of the two parties become naturally oblique to each other, and this is termed the *oblique order*. In like manner, the *concave order* results from an attack by both wings, the center being refused, and the *convex order* from refusing the wings and attacking by the center, etc. The order of battle should result from the position in which the enemy's forces are presented for attack; and as these, if skillfully disposed, will be posted so as to take advantage of the points of vantage which the position they occupy offers, the order of battle for assailing may vary in an infinity of ways. Still it is not to be inferred that one order is not superior to another, or that the choice between them is one at pleasure. In the parallel order, for example, the opposing forces being supposed equal in all points, there is no reason why one point of the enemy's line should be forced rather than another, and, therefore, success depends either upon destroying his whole line, or simply pushing it back; as chance alone will determine a break in any part of his line. In the oblique order, on the contrary, one wing being refused, or merely acting as a menace, the other may be strongly reinforced, so as to overwhelm the wing opposed to it, and, if this succeeds, the assailing army, by its simple onward movement, is gradually brought to gain ground on the enemy's rear, and to threaten his line of retreat. Again, in crossing a river on a bridge, or passing through any other defile to assail an enemy opposing this movement, the order of battle becomes necessarily convex; the extremity of the defile itself becoming the center from which the assailing forces radiate, to enlarge their front, whilst they are obliged to secure the defile on each flank. To lay down rules therefore as to what order of battle should, in every case, be employed would be pure pedantry. Talent, skill, and experience can alone enable a General to decide this point in any given case. As to the distribution of troops belonging to the separate fractions of the entire force, as an army corps, a division, etc., the rule is to so distribute them that they shall fight under the immediate eye of their respective Commanders, and support each other. Having, for example, a division, composed of four brigades, to distribute in line of battle, the question may arise as to whether all four of the brigades shall be in one line, the first, for instance, or two be in the first and two in the second line. By the first distribution, the four brigades will be under the immediate eye of the Division Commander, but their supports of the second line may be a stranger division, and be led by a General, a rival or enemy of their own Commander. In the second case, the Commanding General, being separated from the two divisions in the first line, will not be able to give them that direct supervision as in the first case; but a more hearty co-operation of the brigades and more unity of concert may be looked for than in the contrary case.

The following example will serve to show how much depends upon the General's ability to adapt his troops to the position they are to fight on. Assume an army of about 37,000 troops of all arms, about to attack an enemy's position, the main effort being directed on the enemy's left wing, our left being refused. This force we will suppose to be organized as follows:

40 battalions of 750 men each.......	30,000
12 squadrons " 120 " "	1,440
18 batteries, 72 pieces, 130 men each.	2,340
30 companies of Sharp-shooters	3,000
2 companies Engineer troops.......	200
Total	36,980

In this organization it will be noticed that the proportion of cavalry to the infantry is very small, and that but two guns are allowed to every thousand men; proportions which would be only suitable for a theater of war in which cavalry would but rarely find any but a very confined field of action, and in the case also of excellent infantry, which admits of a reduction in the amount of artillery. Having divided the battalions of infantry into four divisions, one of these is taken to form part of the reserve, to which is assigned the whole of the cavalry, and all the disposable artillery, and the Sharp-shooters. The other three divisions are designed to move on the right, the center, and the left of the enemy's position. As the main attack is on the right, ten companies of Sharp-shooters are attached to it, and five, to each of the other two; ten being with the reserve. In the attack on the right and center, each division, when formed in line of battle, is to occupy only a front of four battalions, the remaining six of each to be so placed, in second or third line, as the respective Generals of division may deem best. Five battalions of the left division will deploy, in echelon, on the left of the second division; the remaining five being in column to the rear, so as to move to the support of either the second or third division as circumstances may demand. Having decided upon this preliminary plan of attack, the three first divisions are put in motion on their respective points, the heads of column on the same level; the reserve following the center column. The advance of each leading column will be covered by an advanced-guard, composed of the Sharp-shooters, and the flank companies of the leading brigade of each, and by one battery of artillery. The deployment will be that which naturally results from the positions of the brigades in column of march; each brigade forming one line, its artillery on the right, the Sharp-shooters in the intervals of the battalions, and the flank companies on the wings. So soon as the three advanced-guards, which are from 1000 to 1500 paces in advance of their respective columns, have come within good range, the Sharp-shooters are thrown out as skirmishers, the flank companies supporting them, each of these companies keeping nearly opposite to the battalion to which it belongs; the artillery, in the mean time, having opened at a convenient range for its round shot. The skirmishers stick to their work until they are either repulsed or called in, when they will retire behind the flank companies; one half of these last forming the new chain of skirmishers, the other half the supports; and, in this order, they fall back, but keeping up their fire, to the intervals between the battalions. The Sharp-shooters then take position to the rear of the first line in the battalion intervals; the flank companies doubling on the wings; and the batteries, which have thus been unmasked, proceeding, on a trot, to the front, to pour in a heavy continued fire on the enemy. The two first divisions in this way enter into the engagement; the third merely covering its position by its batteries.

from each other, and has thrown out one of his batteries on his left, giving it the companies of Sharp-shooters as a support, with the view of checking any movement on this wing. In the mean time, the General Commanding, seeing the affair well under way, has massed his reserve, in rear of the center of the first division, seeing the moment come to complete his stroke, has detached a brigade of the reserve, four companies of Sharp-shooters, six batteries, and the half of his cavalry to the front; giving the artillery orders to take position on the right and left of the batteries of the first division, so as to get a slant fire on the enemy's line; the infantry to mass itself on the right of the artillery, to cover it, and also by proper precautions to guard itself from a flank movement; the cavalry to post itself, in echelon, on the right of the infantry, to prevent a flank movement of the enemy's cavalry. At the same time, two batteries are also sent forward to reinforce those of the second division. To give room for these movements of the batteries, the flank battalions of the first line of the first division are thrown into column in mass, whilst those of the second incline towards the center so as to avoid being behind the batteries. As the reserve is weakened by these movements, the Commanding General orders the second brigade of the third division to take post in rear of the center of the second division, to be on hand for any emergency. The order of battle which, in the early phase of the engagement, was parallel, has now become oblique. The first division, having kept its center battalions of the first line deployed until ready to charge, will, for



This stage of the action is shown in the drawing as the intentions of the Commanding General may have been interpreted by his subordinates. The Commander of the first division has taken a battalion from each of his lines to form a small reserve, which he has placed in a third line, to be ready for any emergency. The Commander of the second division has formed his first line into two echelons, and has placed a second battalion to support the right one of the advanced echelon, and has thrown forward all his Sharp-shooters into the first line. In disposing of his second brigade, he has placed three battalions nearer to the center to strengthen the troops engaged. The Commander of the third division has deployed the battalions of the first line in echelons, at 150 paces this last stage, throw these two battalions also into column, whilst the battalions of the second line will spring forward and fill the intervals of the first, so as to present an unbroken wall to the enemy. In this way the division will move forward rapidly, bringing down the bayonet only when within ten or twenty paces of the enemy's line. If the line should be forced to deploy, to again open fire, the battalions of the first line will fall to the rear, forming as the second, leaving this task to those of the second and the Sharp-shooters. This onward movement of the right will be followed by the center and left, care being taken that the whole movement is performed connectedly. This example gives the spirit of the phases of an action for the case supposed. The problem to be resolved, with the arms now in the hands of troops, being to extend our front as much as possible, without, however, weakening too much our line of battle, so as to bring all the fire we can upon the enemy's line. See *Defensive Battle*, *Mixed Battle*, and *Offensive Battle*.

BATTRE DE FRONT.—An expression meaning to throw cannon-balls in a perpendicular or almost perpendicular direction against any body or place which becomes an object of attack. This mode of attack is less effectual than any other unless *battering in breach*.

BAUDRIC.—A short shoulder-belt which crossed the figure like a scarf, and to which the sword was adjusted so as to be worn behind the person. The habit of thus wearing the sword commenced in the reign of Louis XIII. See *Baldrick*.

BAULOIS.—A piece of punk stuff, used by miners for firing the saucisson, or train.

BAUME FLUX.—A foundry composition, consisting of 3 parts of niter, 1 part of sulphur, and 1 part of sawdust. This flux is capable of inducing the fusion of different metals, partly on account of the heat evolved by deflagration, and partly because it converts a portion of the metal into a more fusible sulphide.

BAVIERE.—The beaver of the helmet. It is sometimes called *mentonière* and is pierced with holes for respiration. Also written *Bavier*.

BAVINS.—In the pyrotechny of warfare, small bundles of easily ignited brushwood, from 2 to 3 feet in length. They are made by arranging the bush-ends of the twigs all in one direction, tying the other ends with small cord, dipping the bush-ends into a kettle containing an inflammable composition, and drying them. They are employed among the combustible materials in fire-ships.

BAXTER KNAPSACK-SUPPORTER.—This consists of two pieces of ash, curved to conform to the shape of the back, fastened together at top and bottom by straps, with rings and straps to secure knapsack or blanket; carried by broad cross-straps across the shoulders and fastened to the supporter behind, and also to the waist-belt.

BAY.—An expression for the length of bridge corresponding to the space between two pontons from center to center.

According to Mr. Bruce, the latest authority on the subject, the tapestry contains, besides the figures of 505 quadrupeds, birds, sphinxes, etc., "the figures of 623 men, 202 horses, 55 dogs, 37 buildings, 41 ships and boats, and 49 trees—in all, 1512 figures." The tapestry is divided into 72 distinct compartments, each representing one particular historical occurrence, and bearing an explanatory Latin inscription. A tree is usually chosen to divide the principal events from each other. This pictorial history—for so it may be called, and indeed, in several particulars, it is more minute than any written history we have—opens with Harold prior to his departure for Normandy, taking leave of Edward the Confessor. Harold is next observed, accompanied by his attendants, riding to Bosham with his hawk and hounds; and he is afterwards seen, successively, embarking from the Sussex coast; anchoring in France, and being made prisoner by Guy, Earl of Ponthieu; redeemed by William, Duke of Normandy, and meeting with him at his Court; assisting him against Conan, Earl of Bretagne; swearing on the sacred relics never to interfere with William's succession to the Saxon throne, etc; and finally re-embarking for England. The tapestry then represents Harold narrating the events of his journey to Edward the Confessor, whose death and funeral obsequies we next see. Harold then receives the crown from the Saxon people, and ascends the throne; and next we have the news brought to William, who takes counsel with his half-brother, Odo, Bishop of Bayeux, as to the invasion of England. Then follow representations of the active war-preparations of the Normans; their embarkation; disembarkation; march to Hastings, and formation of a camp there; the battle and death of Harold, with which the tapestry finishes. The Bayeux tapestry gives an exact and minute portraiture of the manners and customs of the times; and it has been remarked that the arms and habits of the Normans are identical with those of the Danes, as they appear in the miniature paintings of a manuscript of the time of King Cnut, preserved in the British Museum. M. Lancelot appears to have been the first to direct attention to the existence of this curious monument, by a description of an illuminated drawing of a portion of it he had discovered, in a paper presented to the Academy of Inscriptions and

Battle of Hastings.

BAYBERRY TALLOW.—A product of the wax myrtle, much used as a lubricant for bullets.

BAYEUX TAPESTRY.—A web of canvas or linen cloth, 214 feet long by 20 inches wide, preserved in the Public Library, Bayeux, upon which is embroidered, in woolen thread of various colors, a representation of the Invasion and Conquest of England by the Normans. Tradition asserts it to be the work of Matilda, wife of William the Conqueror, and it is believed that if she did not actually stitch the whole of it with her own hand, she at least took part in it, and directed the execution of it by her maids; and afterwards presented it to the Cathedral of Bayeux, as a token of her appreciation of the effective assistance which its Bishop, Odo, rendered to her husband at the battle of Hastings. Some antiquaries contend that it was the work not of Queen Matilda (the wife of the Conqueror), who died in 1083, but of the Empress Matilda (the daughter of King Henry I.), who died in 1167.

Belles-lettres, in 1724. This led to the discovery of the tapestry itself, in the Bayeux Cathedral, by Père Montfaucon, who published an engraving of it in 1730, with a commentary on the Latin inscriptions. In 1767 Dr. Ducarel gave an account of it in his *Anglo-Norman Antiquities*. From that time until 1803, when Napoleon had it conveyed to Paris, the Bayeux tapestry excited little attention. Its exhibition, however, in the National Museum there awakened public curiosity concerning it, and gave rise to various speculations as to its age, intention, etc. The discussion satisfactorily established it to be what tradition asserted it—a contemporary pictorial record of the events of the Norman Conquest. The Society of Antiquaries (London) published an engraving of the whole in the sixth volume of the *Vetusta Monumenta*. The Bayeux tapestry would have been destroyed at the Revolution, had not a priest fortunately succeeded in concealing it from the mob, who demanded it to cover the guns. It was formerly preserved in the Cathedral of Bayeux, where it was wont to be exhibited on certain days every year, in the nave of the church, round which it exactly went.

BAYONET.—A short sword or dagger (usually triangular in cross-section) fitted on to the muzzle of a musket or similar weapon, so as to give the soldier increased means of offense and defense. The name is said to be derived from the town of Bayonne in France, where, it is stated, it was first invented in 1640. The first regiment which appears to have had bayonets attached to their muskets is the Grenadier Guards, so far back as the year 1693. It is stated by Macaulay that in consequence of the awkward mode of attaching the bayonet the English lost the battle of Killiecrankie, as the Highlanders were upon the troops before they could convert their fire-locks into pikes. The bayonets then used were called *bayonets-à-manche*, and had handles which fitted into the muzzles of the guns; but at a later date were introduced the *bayonets-à-douille*, or socket-bayonets, having sockets which enabled the bayonets so to be used as not to interrupt the firing. The use of pikes went out when that of bayonets came in. It seems very probable that the first bayonet was a dagger, which the musketeer stuck by means of its handle into the muzzle of his weapon, to shield him from a cavalry charge; and that the usefulness of the contrivance suggested a permanent arrangement.

Bayonets are now made with great rapidity in the United States, at the Government Rifle Factory at Enfield, and elsewhere. The process of manufacture is very simple. Two pieces of metal are first selected—viz., a piece of the very best cast-steel, 7 inches long by ¾ inch square, and a piece of the best wrought-iron rod, 4 inches long by about 1 inch in thickness. The steel is to form the blade, and the iron the socket-handle. The steel being properly shaped at one end, is joined to the iron by welding. A forging-machine is next employed to give a rough outline of the required shape. Then comes the action of a swaging-machine, with dies which come down upon the metal in great force and counter-dies beneath the metal. The metal is then annealed; turned in a cutting-machine to remove a wire-edge thrown up in the act of stamping; cut to a proper length, and the socket-end made square; drilled and bored, to make the socket hollow; shaped and furrowed along the blade; bent at the neck; hardened and tempered; and finished by a numerous train of minor operations. The drawing represents the triangular bayonet, one fourth size, as at present used on the Springfield rifle in the United States. A is the blade; B, the neck; C, the socket; D, the bridge; E, the stud-mortise; F, the clasp. The bayonet-charge is now one of the most terrible maneuvers of trained infantry, in which each nation fancies itself to excel all others. See *Chillingworth Bayonet*, *Sword-bayonet*, and *Trowel-bayonet*.

BAYONET-CLASP.—A movable ring of metal surrounding the socket of a bayonet, in order to strengthen the socket and render the bayonet less easily detachable. See *Bayonet*.

BAYONET-EXERCISE.—If the sword-exercise be of use to officers, there are many hundreds in the rank and file to whom a proper command of the bayonet is indispensable. In close-quarter engagements there is no weapon more formidable: from its length and weight the thrust of the bayonet gives a terrible wound, and its force is such that there is great difficulty in parrying the attack. Like other small-arms, it is most serviceable when handled on scientific principles; and the art of using it to advantage is so simple as to be very easily acquired, while the exercise, from the weight of the rifle, admirably aids in developing the muscles of all parts of the body.

Of course the bayonet is always fixed at the end of the musket, when it becomes virtually a pike. The position of the feet in the bayonet-exercise remains always the same relatively, and absolutely until advance or retreat be effected. The right foot is thrown back 24 inches, and the weight of the body thrown upon it. The heels are kept in a line with each other, both knees bent and well apart; the right knee directly over the foot, the left easy and flexible, pointing to the front. In this position of the body all the defensive motions of the bayonet are made. In "guard," the bayonet is brought nearly to a horizontal direction, level with the waist, and pointing towards the breast of an advancing enemy. Similarly to "guard," the positions "low," "high," and "second point" are assumed. The butt of the rifle is always kept well to the right side, the hand behind the trigger-guard, and the whole body in attitude to offer great resistance. In "low," the barrel is turned downwards; but in all the other defensive motions it is held upwards. The position of the arms is in each case that which would naturally be taken in placing the bayonet and musket in the required direction. See Fig. 1.

The offensive position of the body is acquired by the extension of the right leg, and bending forward of the left without moving the feet. The butt of the rifle is at the same time pressed firmly to the shoulder. This position is called "point," and constitutes an extension of the weapon in a direction parallel with either of those previously taken. As there were four "guards," so there are four points. The barrel is in each case upward, and the motions for each are similar, except in pointing from "2d point," as may be seen in Fig. 2, when the rifle, seized by the

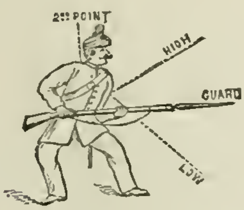


Fig. 1.

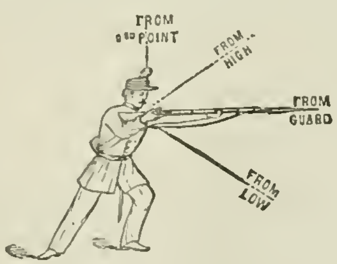


Fig. 2.

Fig. 3.

right hand round the small of the butt, is thrust straight up above the head to the full extent of the arm, the left hand falling along the thigh, and the legs being straightened so as to form an isosceles triangle. "Shorten arms" is a useful motion, both as a defense and as a preparation for a strong attack. It consists in carrying the butt back to the full extent of the right arm, while the barrel (downwards) rests upon the thick part of the left arm. The body is thrown upon the right leg, and the left straightened. This powerful position is seen in Fig. 3. In all the guards and points, and also "shorten arms," the bayonet may be turned directly to the front, to the right, or to the left, as circumstances may suggest. In contending with a swordsman, the action of changing from right to left, when at the "high" or "low," is sufficient defense against the ordinary cuts of the latter. See *Cavalry Parries*, *Disengage*, *Guard*, *Lunge*, *Parry*, and *Thrust*..

BAYONET-SCABBARD.—A leather or metallic case for carrying the bayonet, suspended from the belt.

BAZAR.—The sutler establishment which accompanies a native regiment in the India service wherever it goes.

BEACH COMBINATION SIGHT.—A sight extensively used for both sporting and target practice. It is so constructed that by turning it up or down the rifleman can have a globe or open sight at will, a peep-sight being attached to the small of the stock. The globe of this sight is so constructed as to permit the use of all descriptions of sights, detachable pieces of the various forms in use being slipped into a slot in the globe and held by a screw. There is a great diversity of opinion as to what is the best form of sight; but the four disks represented are favorites with many of the best long-range shots.

Beach Sight, and Disks.

A spirit-level and wind-gauge adjustment is usually attached to this sight, and insures any degree of nicety.

BEACH-MASTER.—Formerly a Superior Officer appointed to superintend the disembarkation of an attacking force, who holds plenary powers, and generally leads the storming party. His acts when in the heat of action are unquestioned.

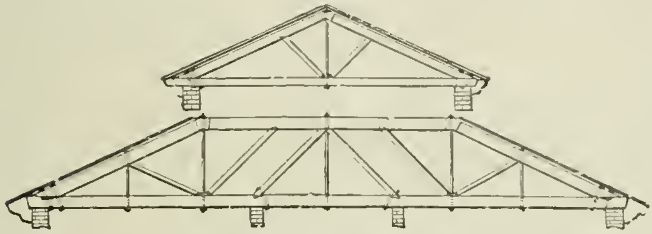
BEACON.—Any signal set upon a height, but especially the alarm-fires at one time used to spread the intelligence of foreign invasion or other great event. These fire-signals were in use in the earliest times, and notices of them are found in the literary remains of ancient Persia, Palestine, and Greece. They were made by kindling a pile or bale of wood on the tops of lofty mountains, and keeping the flame bright by night, or having the fire so covered as to emit a dense smoke by day. There were various preconcerted modes of exhibiting the light or smoke, so as to indicate the nature of the intelligence. Thus, an Act of the Parliament of Scotland, in 1455, directs that one bale on fire shall be warning of the approach of the English in any manner; two bales blazing beside each other, that they are *coming indeed;* and four bales, that they are coming in great force.

An early instance of beacon-signals is found in the Book of the Prophet Jeremiah, in his call, in chapter vi. 1, to the people of Benjamin to kindle a fire-signal on one of their mountains: "Set up a sign of fire in Beth-haccerem; for evil appeareth out of the North, and great destruction." An instance of the use of a line of beacons in very ancient times is given in a passage of the tragedy of *Agamemnon*, by the Greek poet Æschylus. The Commander-in-Chief of the Greek army at the Siege of Troy is represented as communicating the intelligence of the fall of the city to his Queen, Clytemnestra, at Mycenæ, in the Peloponnesus. The line consists of eight mountains, and the news is supposed to be conveyed in one night from Troy.

In England, the beacons were kept up by a rate levied on the Counties, and had watches regularly stationed at them, and horsemen to spread the intelligence during the day, when the beacons could not be seen. They were carefully organized while the Spanish Armada was expected. In the beginning of 1856, an old beacon-work on Malvern Hill, in Worcestershire, which had done its part in the former days in spreading the intelligence of the appearance of the Armada, of the approach of the Young Chevalier, and of that of the Dutch fleet afterwards dealt with by Admiral Blake, was lighted up in anticipation of the close of the Crimean War, and afforded an interesting amusement to scientific persons in estimating the distance at which the blaze could be seen from distant mountains. See *Signal*.

BEALS GUN.—A breech-loading rifle having a fixed chamber closed by a movable breech-block, which slides in the line of the barrel by indirect action, being moved by levers from below. It is opened by depressing the lever; this brings down the rearmost of two folding-wedges which form the breech-block, by means of a toggle or link, and at the same time withdraws the upper section of the block to its full extent and then drops it out of the way of the cartridge. The hammer is simultaneously brought to the half-cock. The piece is closed by reversing the action of the lever, when the sections of the block are brought into place. The last movement of the upper section being in the line of the barrel, thus tends to press the cartridge into the chamber if it be not already completely inserted. The piece is locked by the position of the breech-block, and is fired by a tang-lock of the usual pattern. Extraction and ejection are accomplished by a sliding extractor on the side of the barrel, impelled backward by a spring, when by the descent of the breech-block the way for it is clear. See *Rifle*.

BEAM.—A straight piece of wood or iron in the frame of a structure, usually occupying a relatively elevated, horizontal, and transverse position; as the beams of a magazine, stretching across it, and supported by the side walls or posts. Relative size, character, position, and importance have caused the word to be applied to a long straight piece in a machine or tool, whether poised, journaled, or fixed. Specific denominations have been conferred upon beams in framed structures. 1. *Tie-beam;* one uniting the ends of a pair of principal rafters, or a pair of posts, to prevent spreading or divergence. 2. *Collar-beam;* a horizontal strut connecting and bracing two opposite rafters. 3. *Dragon-beam;* a piece of timber to receive and support the foot of the hip-rafter. 4. *Straining-beam;* one used in a truss or frame to confine principal parts in place. 5. *Camber-beam;* a horizontal beam in a simple span, whose sill has two posts, two struts, and a camber-beam uniting the top of the posts. 6. *Hammer-beam;* a tie-beam proceeding from the feet of a pair of principal rafters, but having its middle portion removed; the ends of the gap are stayed by ribs springing from corbels below, and support other ribs which spring into an arch. 7. *Binding-beam;* a tie-beam which binds together portions of a frame. 8. *Truss-beam;* the principal horizontal timbers of a truss, called the *top* and *bottom chord*, and from which proceed the *stays* and *braces* which hold and push respectively, so to speak, and confer rigidity upon the frame. 9. *Summer-beam;* a central floor or ceiling timber, resting at its ends upon the walls or the girders of the exterior frame, and supporting the ends of the joints which are notched into it. 10. *Arched-beam;* a beam bent, cut, or built into an arched form to support a structure. 11. *Built-beam;* a beam made of several parts, scarfed or strapped together. 12. *Kerfed-beam;* one whose under side has a number of transverse kerfs penetrating to a certain depth, so as to enable the beam to be bent. 13. *Ground-beam;* a sill for a frame. 14. *Box-beam;* a form of girder having a double web, inclosing a box or cell. It is usually of iron. The drawing shows the beams most frequently used in fortification-work, and the functions they perform. In the case of beams supporting weights over ditches, ravines, etc., if the



depth of the beam be doubled, other things equal, its strength will be increased four times; if its breadth be doubled, other things equal, its strength will be doubled. By increasing the distance between the supports, the strength of the beam is decreased in the same ratio. Half the distance between the supports will enable the beam to bear twice the load. Place a prop or skid under the center of the beam, when possible. If instead of concentrating the load at the center of the beam, it be equally distributed over it, the beam will bear twice the load. The effect of the load on a beam will decrease in the ratio of its proximity to the support. A beam fixed at one end and loaded at the other will bear one half the weight of the same when supported at each end. The strength of round timber is about one half of that of square timber whose side equals the diameter of the round timber.

BEAM-CALIPER.—An instrument for measuring diameters. It usually consists of a square of steel or iron, with two branches, one of which is fixed and the other sliding. The inner edges of the two branches, when pushed together, lie, of course, in contact with each other throughout their length. obtaining correct measurements in the arsenal. The side represented is graduated upon the bar to inches and fiftieths of an inch, and by the aid of a vernier is read to thousandths of an inch. The opposite side is graduated to inches and sixty-fourths of an inch. The outside of the jaws is of suitable form for taking inside measurements, and when the jaws are closed measures 250 one-thousandths of an inch in diameter. This caliper will measure one inch and eleven sixteenths, outside diameter, when the jaws are opened full size. The instrument can be furnished with millimeters (in the place of sixty-fourths of an inch), and provided with a vernier to read to one fiftieth of a millimeter. See *Calipers*, *Gauge*, and *Inspection of Ordnance*.

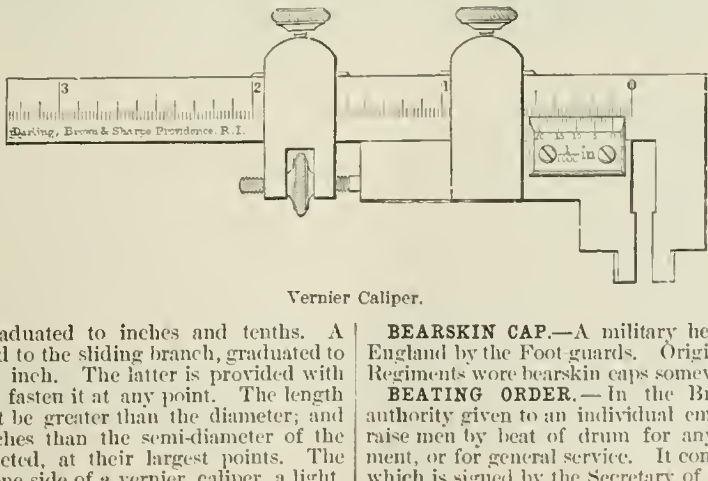
BEAM-CARRIAGE.—In artillery, that part of a gun-carriage included between the breast and trail-point. In the old pattern English field-carriages, the beam is formed of a solid block of wood, if timber of sufficient scantling can be obtained; but if not procurable, it is formed of two pieces tabled one into the other. In this form it is called a *block-trail* carriage. Formerly light field-carriages consisted of two brackets fastened together by transoms; but this form, though it possessed strength, was found to be awkward and unhandy for quick maneuvering; the block-trail, therefore, was substituted for all light field-carriages, and has been also adopted for certain siege-carriages. Since the introduction, however, of wrought-iron guns into the service, the bracket pattern has been re-introduced, and the carriage, which is made of wrought-iron, has the brackets and trail in one. The present pattern of iron carriages is not yet universal in the service, but will be so in the future.

BEAM-COMPASS.—An instrument for describing large circles, and used in connection with the trunnion-square, in the inspection of ordnance. It has a beam or rod, and two sliding sockets which carry the steel point and the pencil or pen points. Set-screws on the sockets hold them to their places on the beam. See *Trunnion-square*.

BEAR.—1. A portable punching-machine for iron plates. A *punching-bear*, much used in armories.

2. The Order of the Bear was instituted by the Emperor Frederick II., in 1213, by way of acknowledgment for the service the Swiss had done him, and in favor of the Abbey of St. Gall. To the collar of the order hung a medal, on which was represented a bear raised on an eminence of earth.

BEARD.—The reflected points of the head of an ancient arrow, particularly of such as were jagged.



Vernier Caliper.

The beam is graduated to inches and tenths. A vernier is attached to the sliding branch, graduated to hundredths of an inch. The latter is provided with a thumb-screw to fasten it at any point. The length of the beam must be greater than the diameter; and that of the branches than the semi-diameter of the guns to be inspected, at their largest points. The drawing shows one side of a vernier caliper, a light, convenient, and valuable instrument for use in

BEARSKIN CAP.—A military head-dress worn in England by the Foot-guards. Originally the Fusilier Regiments wore bearskin caps somewhere about 1805.

BEATING ORDER.—In the British service, an authority given to an individual empowering him to raise men by beat of drum for any particular regiment, or for general service. It consists of a warrant which is signed by the Secretary of War, or issued in his name by the Adjutant-general.

BEATING ORDERS.—Instructions or orders given to recruiting parties before they leave the headquarters of their regiment; they are obtained, on application, by Commanding Officers from the Secretary of State for War. When recruiting parties are quartered in places where a Superintending Officer is stationed, they are to deposit their beating orders with him.

BEATING THE WIND.—A practice in use in the ancient method of trial by combat. If one of the combatants did not appear in the field at the time appointed, the other was to make so many flourishes with his weapon, by which he was entitled to all the advantages of a conqueror.

BEAT OF DRUM.—In military matters, a signal or instruction conveyed by a particular mode of drum-beating. It is an audible semaphore, a telegraph that speaks to the ear instead of the eye. There are many varieties, known by the names of the general, the reveille, the assembly, the foot-march, the grenadiers' march, the retreat, the taptoo or tattoo, the call to arms, the call to church, the pioneers' call, the sergeants' call, the drummers' call, the chamade, the rogue's march, the long roll, etc. Some of the same instructions or commands are also given by the bugle, and some by the trumpet.

BEAUCEANT.—The standard of the Knights Templar; it was white on one side and black on the other. Also written *Beaucent.*

BEAULIEU PROJECTILE.—The plan of this projectile was brought forward as early as 1842. It consisted of twelve zinc studs, or buttons, placed on the shot in pairs, so as to project into the six rounded grooves of the gun. One stud, or projection on the gun, was arranged to push the bearings of the shot tight against those sides of the groove on which it would press in going out, so as to decrease jarring and play.

BEAVER.—That part of a helmet covering the lower part of the face, which shifts on pivots to allow the wearer to drink. The word is derived from the Latin *bevere*, to drink, and is sometimes written *Bever.*

BEBRA.—A sort of javelin used by the ancient Germans; it was an imitation of the *pilum* of the Romans.

BEC DE CORBIN.—A kind of halbert formerly used by the body-guards of the kings of France.

BECHLIS.—Light cavalry of the Turks, composed of picked men and horses.

BED.—1. In artillery, the frame or rest on which mortars are placed and fired from. Mortars have traveling carriages, which are attached to a limber. In battery the carriage is unlimbered, the wheels removed, and the body laid flat upon the ground. Mortar-beds for the larger-sized mortars, viz. the 13-, 10-, and 8-inch land service, are made of iron, and the smaller of wood, viz. the $5\frac{1}{2}$- and $4\frac{2}{5}$-inch. Mortars are elevated by means of quoins.

2. Straw and bedsacks are allowed to soldiers for bedding. The introduction of single iron bedsteads will make it necessary to increase the allowance of bed-furniture. In Prussia and other countries, hammocks are used in place of bedsteads. *Bed* has also other applications: as, camp-bed; bed of a gun-lock; bed of sand; bed of a river; to separate the beds of stone in a quarry, etc.

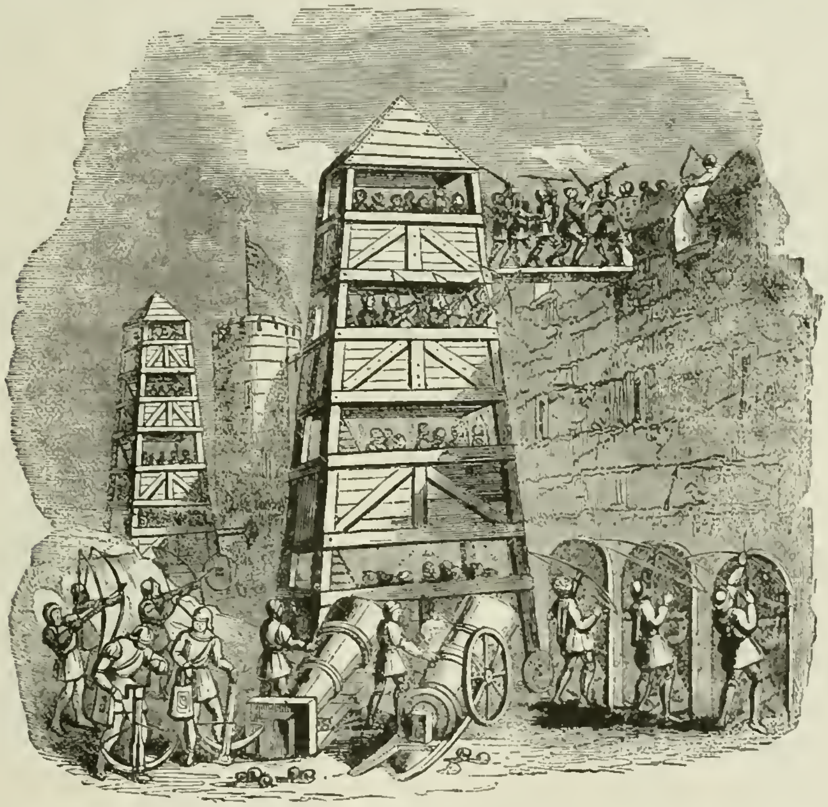
BEDAINES.—Stone bullets which were thrown from catapults during the Middle Ages.

BEDOUINS—BEDUINS.—Arabs who lead a nomadic life, and are generally regarded, according to tradition, as the descendants of Ishmael, and the aborigines of Arabia. The most ancient notices found in Scripture agree, in their descriptions of the manners and customs of the Bedouins, with the facts of the present time. As nomads, the Bedouin Arabs have no united history, but only a collection of genealogies. They have but seldom appeared as a united people, taking a prominent part in the world's politics, and have never been entirely held in subjection by any foreign power. The desert of Arabia, especially the plateau of Nedjid, is their central place of abode; but, even in ancient times, they had spread themselves over the deserts of Egypt and Syria; and in later times, after the decay of ancient civilization, they entered Syria, Mesopotamia, and Chaldæa. The conquest of Northern Africa, in the seventh century, opened up to them still vaster tracts, and they soon extended themselves over the Great Desert to the shores of the Atlantic Ocean. At present, they are to be found scattered over an immense breadth of territory—viz., from the western boundary of Persia to the Atlantic, and from the mountains of Kurdistan to the Negro Countries of Sudan. In the cultivated lands of Mesopotamia, Chaldæa, the Syrian confines, Barbary, Nubia, and the north of Sudan, the Arabs are found intermingled with other nations; but in the deserts they have maintained their distinct character and independence. The characteristics of the Bedouins, as herdsmen and robbers in the desert, are intimately connected with the nature of their habitation. Their abstinent, precarious, and often solitary mode of life makes them disposed to exercise mutual hospitality; but their independence, love of liberty, and other good qualities are associated with violent passions and an infamous love of plunder, which is utterly reckless of the rights of property. They are generally well-made men, lean, sinewy, and active; but, on account of frequent hardships and privations, are commonly below middle stature. Their senses, especially sight, are keen, and their carriage is free and independent. The nose is commonly aquiline, the face rather lengthened, and the eyes are well shaped and expressive of both daring and cunning. In complexion, they have various shades of brown. With the exception of certain tribes in Syria, all the Bedouins are professedly Mohammedans, but by no means strict in the observance of their religious rites and duties. Their *Marabouts*—a class of ascetics—take the place of priests, and exercise considerable influence in all social and public affairs. As the Arabs have no settled government or policy, religious traditions and customs form the only bond of order and union among them. Though their intellectual powers are naturally good, they are miserably destitute of solid knowledge. Their endless tales and poetical effusions show a wonderful activity of imagination and an oriental love of hyperbole. The relation of the sexes to each other is less constrained than among the settled peoples of the East, and a substitute for polygamy is found in a frequent interchange of wives. Their favorite pastimes are the chase, ball-play, dancing, songs, stories, and the *dolce far niente* (pleasant laziness) of drinking coffee and smoking narghiles. Their diet is principally derived from their herds, but includes a few vegetables, and even locusts and lizards. Honey is also a principal luxury with all classes, and, moreover, one which has a religious sanction, for it was indulged in by Mohammed himself, who makes copious mention of it in the Koran. They manufacture their own woolen clothing, which consists of the *haikh*—a long, wide garment fastened on the head, and descending to the feet—and the *burnoose*, a large mantle. Only superior men wear breeches and linen or cotton shirts. The hair of the head is shaven, but the beard is a favorite object of cultivation. The political condition of the Bedouins may be styled patriarchal. One or more families, the males of which bear the title of *Sheik*, form the core of a tribe, and along with the marabouts, or priests, constitute a kind of aristocracy. Out of their number the superior *Sheik*, or Kaid, is elected, who rules in patriarchal style over the whole tribe. This general sketch of the Bedouins applies chiefly to the true nomads, or "dwellers in the desert," and is subject to several modifications with regard to tribes located in Barbary, Syria, and Mesopotamia, who practice agriculture and dwell in houses.

BED-SORES.—A very troublesome complication of disease, to which wounded soldiers are liable when for a long time confined to the ambulance or stretcher, and either unable or not allowed to change position. Thus they are liable to occur in cases of continued fever, or any other prolonged debilitating disorder, in paralysis from injury of the spinal cord, and in cases of fracture of the thigh. The skin at certain projecting bony parts, chiefly about the region of the buttocks, or on the heel, is apt to inflame, ulcerate, and slough, especially if the patient is not kept perfectly clean. The patient sometimes complains of a sense of discomfort at the parts, as if he were lying on dry crumbs of bread; at other times he seems to feel nothing. Hence, in all cases of prolonged supine position, the parts naturally pressed upon by the weight of the body should be carefully examined every day or two, as prevention is far easier than cure. When a long confinement to bed is expected, attempts should be made to thicken the cuticle, and enable it to bear pressure better, by rubbing the skin with a stimulant such as spirits or eau-de-Cologne. If the part, when first seen, looks red and rough, further damage is often prevented by covering it with a piece of calico on which soap-plaster has been spread; the local pressure may be removed by air-cushions specially constructed for cases of this kind, and in many instances Arnott's water-bed affords great comfort. If the case is one in which it is admissible, the patient should be made to alter his position frequently. When there are excoriations, and a threatening of sloughing, a poultice composed of equal parts of bread-crumbs and of finely-grated mutton-suet, mixed over the fire in a saucepan, with a little boiling water, is often a comforting and useful application. After sloughing has fairly begun, stimulating applications, such as resin-ointment, must be applied. It is worthy of notice that bed-sores come on earlier in cases of fractured spine than in any other: they generally appear by the fourth day, and have been seen two days after the accident. They commonly form one of the most powerful agents in destroying life in cases of this accident, diseases of the urinary organs being the other. See *Air-bed and Pillow*.

BEECH-TREE.—Only one species (*Fagus sylvatica*) is common to Europe. In England, the Buckinghamshire and Sussex beech-trees are esteemed the best. The color of the wood is whitish brown, of a uniform texture and closeness. It is considered to be almost chemically free from foreign matters. It is used in the manufacture of fuses, and no wood has yet been found equal to it for that purpose. It is also valuable for wooden types in printing.

BEEF-EATER.—A term now applied jocularly to certain functionaries in England belonging to the Yeomen of the Guard, who, ever since the time of Henry VII., have formed part of the Train of Royalty, attending the Sovereign at royal banquets and other state occasions. They have maintained the same costume, with a slight alteration made in 1858, for nearly four centuries; and this costume has had much to do with their attractiveness to sight-seers. The origin of the term is a case of what Dr. Latham calls "words of foreign simulating a vernacular origin." It was originally *beaufetier* or *buffetier*, one who attends the *buffet* or sideboard. Similar instances of false etymology, arising from resemblance in sound, are seen in *Shot-over* (a hill near Oxford), from *Chateau Vert; sparrow-grass*, from *asparagus; ancient*, for *ensign; dog-cheap*, from the old English *god-kepe*, i.e. *good-cheap*, meaning *a good bargain;* etc.



Beffroi, or Breaching-tower.

BEER-MONEY.—A peculiar payment to Non-commissioned officers and soldiers in the English army. It was established in the year 1800, at the suggestion of the Duke of York, and consisted of one penny per day for troops when on home-service, as a substitute for an issue of beer and spirits. It continued as an addition to the daily pay until 1873, when, the stoppages for rations having been abolished, the opportunity was taken to consolidate beer-money and pay proper.

BEETLES.—In a military sense, very large wooden hammers used for driving down palisades, and for other purposes.

BEFFROI.—The name given to a tower used in the military sieges of ancient and mediæval times. When a town was to be besieged, a movable tower, as high as the walls, was brought near it; and this tower was the *beffroi.* Its use is more than once spoken of by Cæsar in his account of his campaigns in Gaul. Froissart describes, with his usual spirit, a beffroi employed at the siege of the Castle of Breteuil in 1356. At the siege of Jerusalem by the Crusaders, a beffroi was carried in pieces, put together just beyond bow-shot, and then pushed on wheels to a proper position. The object of such towers was to cover the approach of troops. Sometimes they were pushed on by pressure, sometimes by capstans and ropes. The highest were on six or eight wheels, and had as many as twelve or fifteen stories or stages; but it was usual to limit the height to three or four stages. They were often covered with raw hides, to protect them from the flames of boiling grease and oil directed against them by the besieged; and there was a hinged drawbridge at the top, to let down upon the parapet of the wall, to aid in landing. The lower stage frequently had a ram; while the others were crowded with archers, arbalisters, and slingers; or there were bowmen on all the stages except the top, which had a storming or boarding party. During the wars under Charles I., the Royalists made a beffroi to aid in the besieging of a town or castle in Herefordshire; it was higher than the defense-works, and was provided with loop-holes, a bridge, etc.; but the Roundheads captured it before it could be applied to use. Ducange thinks that the name of *belfry* given to a bell-tower was derived from the warlike machine called the beffroi or belfry. See *Battering-ram.*

BEG—BEY.—A Turkish title, rather vague in its import, and commonly given to superior military officers, ship-captains, and distinguished foreigners. More strictly, it applies to the Governor of a small district, who bears a horse-tail as a sign of his rank. The Governor of Tunis has this title.—" Beglerbeg," or, more correctly, Beilerbegi (" Lord of Lords"), the title given to the Governor of a province who bears three horse-tails as his badge of honor, and has authority over several begs, agas, etc. This superior title belongs to the Governors of Rumelia, Anatolia, and Syria.

BEHOURD.—A name given during the Middle Ages to a combat on horseback, lance in hand; also a tilting of cavaliers, which took place at public amusements. Also written *Bihourt* and *Bohurt.*

BELFRY.—A tower of wood, movable on wheels, used in sieges in the Middle Ages. Sometimes a battering-ram was used with it. It was as high as the wall attacked, and a drawbridge was rigged at the top to be dropped on the wall when occasion offered. See *Beffroi.*

BELIDOR SYSTEM OF FORTIFICATION.—This system resembles Rosard's method, but is not so good. A first enceinte consists of small bastions; a second of large bastions with retrenchments; a third of outworks. The reduits of re-entering places of arms are formed of loop-holed walls. The glacis is further defended by lunettes. The profusion of masonry renders this system impracticable, and the great number of outworks necessitates a very strong garrison. Its great merit consists in obliging the besieger to employ a numerous artillery to ricochet a front, and to pass through four periods of breaching-batteries.

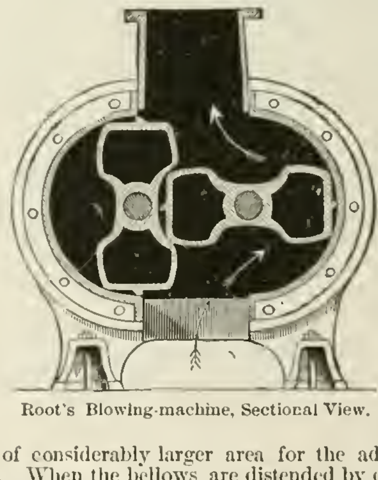
BELIER.—A battering-ram invented by the Carthaginians about 441 B.C.; used in ancient times for siege purposes. Also a wooden machine for driving wedges under a ship's bottom or heavy ordnance.

BELLIGERENT.—Waging war. Hence any two or more countries at war with each other are termed belligerents.

BELL-METAL.—An alloy composed of copper and tin, either alone or with the addition of a greater or less proportion of other metals, usually zinc and lead. It is a species of bronze, and from its hardness and sonorousness is better adapted than any other metal for the purpose from which it derives its name. The usual proportion is 75 parts copper and 25 parts tin, but constituents vary from 50 copper, 33 zinc, and 17 tin, to 80 copper, 10 tin, 6 zinc, and 4 lead. The proportion 78 copper to 22 tin is generally recognized in commerce. This metal is variously employed in the armory.

BELLONA.—The goddess of war among the Romans. She was described by the poets as the companion, sister, wife, or daughter of Mars; she was also represented as armed with a bloody scourge, and as inspiring her votaries with a resistless enthusiasm in battle. In the war with the Samnites, the Consul Appius Claudius vowed a temple to Bellona, which was erected afterwards on the Field of Mars. In this temple the Senate gave audience to embassies from foreign powers, and also to Consuls who had claims to a triumph which would have been nullified by entrance into the city. The priests of the goddess were styled *Bellonarii,* and practiced sanguinary rites, such as cutting their own arms or feet and offering (or even drinking) the blood in sacrifice. This was especially done on the *dies sanguinis* (day of blood), March 24.

BELLOWS.—The earliest blowing-machine was, doubtless, some form of the common bellows, the idea of which is supposed to have been derived from the lungs. A very primitive form of this instrument is still in use in some Eastern countries, consisting simply of the skin of some animal sewed into a rude bag with a valve and nozzle. The older forms of domestic bellows are all constructed on the same principle—viz., a chamber formed of two boards with flexible leather sides, having at one end a nozzle with a narrow mouth, and in the lower board a



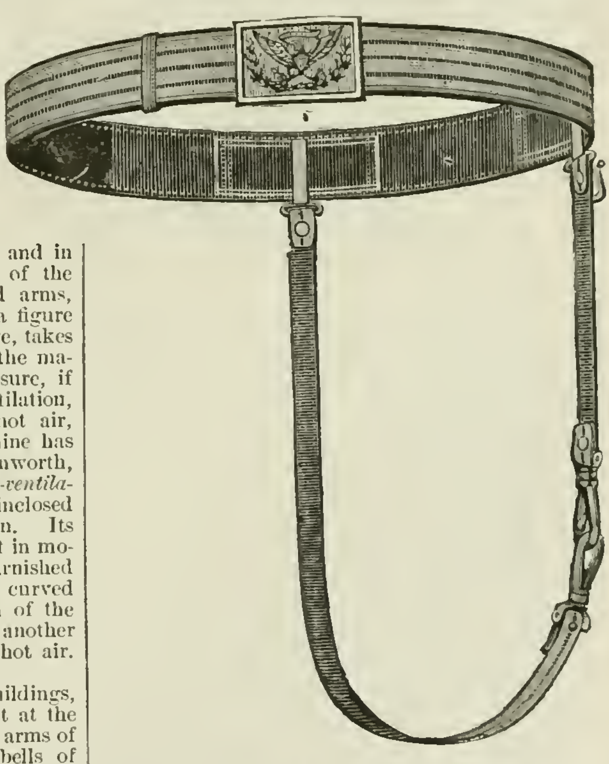
Root's Blowing-machine, Sectional View.

valve of considerably larger area for the admission of air. When the bellows are distended by drawing the boards apart, air is sucked in by the valve, to replace the vacuum which would otherwise be formed; and then, when the boards are being closed, the valve, which only opens inwards, is shut by the compressed air; and the latter, having no other escape, is forced out at the nozzle. The great fault of the common bellows is that it gives a succession of puffs and not a continuous blast. One remedy for this was to use two bellows, so that one was blowing while the other was filling; but it was afterwards found that the double-bellows secured a still more uniform blast. This machine is merely the common bellows with a third board of the same shape as the other two placed between them, so as to form two chambers instead of one. The middle board is fixed, and both it and the lower one have valves placed in them opening inward. A weight on the lower board keeps the under chamber filled with air; and when this board is raised by a lever or otherwise, the air which it contains is forced into the upper chamber. The exit-pipe is attached to the latter, and a weight is placed on the upper board sufficiently heavy to press the air out in a continuous stream, the continuity being maintained by the large quantity of air always present in the upper chamber, and the uniform pressure of the weight. Sometimes a spring is used instead of a weight to press out the air. Even with the double bellows, however, the constant refilling of the upper portion from the lower prevents the blast from being quite regular

Fanners are, at present, much employed for creating blasts to melt pig-iron in foundries, and are used instead of bellows in smithies, on account of their greater convenience and the steadier blast which they yield. A domestic bellows has even been introduced on the fan-principle. The fan is also much used in the ventilation of buildings, ships, and mines. For the last it is now considered preferable to the plan of furnace-ventilation, especially where there are fiery seams of coal. A modified form of the fan, called a *centrifugal disk*, patented by Mr. Rammell, was successfully employed by the Pneumatic Dispatch Company for the transmission of the mail-bags. An ingenious but simple ventilator is in use in the mines of the Harz for supplying fresh air. It consists of two long cylindrical vessels, one of which is so much smaller as, when inverted, to move up and down inside the other. The outer one is partly filled with water, and has a tube leading through the water down to the mine. The inner inverted cask, which has a valve opening inwards, is lifted and then pressed down, so forcing air through the tube. The excellent and well-known blowing-machine of the Messrs. Roots, shown in section in the drawing, may be thus described: A pair of horizontal shafts, geared together at both ends, traverse a case of the form of two semi-cylinders, separated by a rectangle equal in depth to the diameter of the semi-cylinders, and in width to the distance between the centers of the shafts. These shafts carry a pair of solid arms, each having a section somewhat resembling a figure of eight, the action of which, as they revolve, takes the air in by an aperture at the bottom of the machine, and expels it with considerable pressure, if required, at the top. For the purposes of ventilation, and also for expelling accumulations of hot air, dust, waste flyings, etc., in factories, a machine has been constructed by Mr. J. Howorth, Farnworth, Bolton, called a *Revolving Archimedean Screw-ventilator*. It consists of an Archimedean screw inclosed in a tube with proper means of lubrication. Its diameter is 30 inches, and it is made to be set in motion by steam or other power, but it is also furnished with a hood, on the top of which there are curved vanes, which turn the screw by the action of the wind. Immediately beneath these there is another series of lateral vanes for the escape of the hot air. See *Blower* and *Iron*.

BELLS OF ARMS.—Tents or masonry buildings, formerly used in India, and to some extent at the present day, for the deposit and care of the arms of each company of a native regiment. The bells of arms were generally built in front of the lines of the regiment and behind the parade-ground. The tent is frequently painted with the color of the facings of the regimental uniforms.

BELTS.—1. Leathern suspenders of different kinds and for various purposes, viz.: *Sword* belts, to which swords hang (the drawing represents the New Regulation Full-dress Belt in the United States Army); *Shoulder* or *Cross* belts, broad leathern belts, crossing from the right shoulder, and to which the pouch is affixed; and leathern straps fixed round the waist, by which a sword or bayonet is suspended. See *Equipments*.—2. Endless strips of flexible material, usually leather or India rubber, to transmit motion or power from one pulley to another. Ropes and chains serve a similar purpose. When chains are used, the pulleys are provided with projections which engage in the links of the chains and prevent slipping, and the mechanism has the positive relations of a rack and pinion. Ordinary flexible belts transmit power by the friction between them and their pulleys. The pulley which communicates motion is the driving pulley; that which receives, the driven pulley; that part of the belt which runs from the driven pulley to the driver is the driving part of the belt, since it is pulled by the driver, and in turn pulls on the driven pulley; the part of the belt which runs from the driver to the driven pulley is the slack belt. The strain on the driving belt is the sum of the strain of the belt on the pulleys when there is no motion plus the strain of the friction; that on the slack belt is the same strain on the pulleys less the friction. Thus, if a belt is stretched over its pulleys with a strain of 10 lbs. per inch of width, and it requires 5 lbs. to make it slip, then the strain on the driving belt is $10 + 5 = 15$ lbs., and the strain on the slack belt is $10 - 5 = 5$ lbs. per inch of belt. As the two parts of the belt are unequally strained there will be a tendency to move, or *creep*, towards the driving belt over the driven pulley. Hence the velocity ratio of the two pulleys will not exactly follow the inverse ratio of their radii, and the belt cannot be relied upon for giving uniformity of motion. For driving most



machinery, the fact that the belt is elastic, and will slip if unduly strained, makes it a favorite method of communicating power. Rubber belts transmit about 25 per cent more power than leather, because the surface of the rubber conforms more perfectly to the minute inequalities of the pulley surface, and thus acquires a closer grasp. The texture of a rubber belt is more uniform than can be had in leather, and therefore a wide rubber belt will wear more evenly. In damp and exposed places rubber is more durable than leather. If, however, the belt is to be shifted back and forth, as in the stopping and starting of many machines, or in cross-belting—wherever the edge of the belt is liable to wear—leather is preferable. If the pulley be higher at the center than at the side, or higher at one side than at the other, the belt will creep towards the highest part; for this reason the surface of the pulley is usually made not cylindric, but of greater diameter at the center. If this be overdone, the belt does not pull, except along its central part. The pulleys usually lie in the same plane, and with their axes parallel; but this is not necessary, provided that the course of each part of the belt—the driving and the slack part alike—be in the plane of the pulley toward which that part of the belt runs; the belt being always delivered by one pulley into the plane of the other. Transmission of power by belts is more common in the United States than in Europe. Hempen or wire ropes, running over large pulleys with V-shaped edges, are used to transmit power to long distances. The U. S. Arsenal at Rock Island, Ill., carries more than half a mile by one rope the power of four large turbine wheels, sufficient for all the present need of the machine-shops. Such cables have been called teleodynamic cables. They can be run as fast as one mile per minute, and without covering will last three years. Intermediate sheaves are required at every 300 or 400 feet. See *Transmission of Power for Military Purposes.*

BEND.—One of the honorable ordinaries, or more important figures in Heraldry. It is formed by two parallel lines, which may be either straight or indented, engrailed, etc., drawn from the dexter to the sinister base, and consequently passing athwart the shield. The bend occupies a fifth part of the shield in breadth, if plain; and a third part, if charged. The bend is supposed to represent a shoulder-belt, or scarf worn over the shoulder. When heralds speak of the bend simply, the bend-dexter is understood, the bend-sinister being always expressly mentioned. *Bend-sinister* is the bend-dexter reversed, and passing from the left to the right side of the shield, as the dexter does from the right to the left. There are four diminutives of the bend, viz., the *bendlet*, the *garter*, the *cost*, and the *ribbon*. The terms *in bend, per bend, bendy*, etc., are of frequent occurrence in heraldic works, and signify that the charge is placed, or the shield divided, diagonally in the direction of the bend. See *Bar, Bastard Bar*, and *Heraldry.*

Bend. Bendlet. Garter. Cost. Ribbon.

BENGAL LIGHT—BENGOLA.—A brilliant signal-light used at sea during shipwreck, and in ordinary pyrotechny for illuminating a district of country. It is prepared from niter, sulphur, and the tersulphuret of antimony. The materials are reduced to fine powder, thoroughly dried, and intimately mixed in the following proportions by weight: niter, 6; sulphur, 2; tersulphuret of antimony, 1. The mixture constitutes the bengola, and when kindled by a red-hot coal, red-hot iron, or flame, immediately bursts into rapid and vivid combustion, evolving a brilliant, penetrating, but mellow light, which, during the darkness of night, readily overcomes the gloom for a considerable space. As the fumes evolved during the combustion of the bengola contain an oxide of antimony and are poisonous, the light cannot be used with safety in rooms or inclosed spaces.

BENICKE.—A kind of military fête among the Turks, similar to a tournament, but without the presence of ladies.

BENTON CARTRIDGE-BLOCK.—A projecting bolster is left at the forward end of the lock-plate and is under-cut in front and rear. On to this it is designed to slip a detachable magazine-block holding one row of six cartridges, and faced on the inner side with a steel plate securely riveted to the body of the block, and containing a dovetail-groove, corresponding to the bolster on the lock-plate. When fixed, the block is locked in place by a rotary cam on its inner surface, connected with a thumb-piece on the outside and turned by it so as to engage against the lower edge of the bolster. The cartridges are held in the block, in case of its being accidentally overturned, by copper bushings with which the holes are lined.

This block is intended to be issued as a part of the soldiers' equipment, and to be carried full in the cartridge-box. To this end, additional protection against dropping the cartridges is afforded by a leather strap, fastened at the forward end of the block and passing over the heads of the cartridges to a button on the other end of the block. Colonel Benton also proposed that the portion of the stock just to the left of the receiver of a Springfield gun might be enlarged so as to accommodate five cartridges, caliber .45. They were to be held in place by a lip on the side of the breech-block when the breech was closed, and when opened by the copper bushings. See *Hare* and *Metcalfe Cartridge-block.*

BENTON DYNAMOMETER.—This instrument, invented by Lieutenant-colonel James G. Benton, Ordnance Department, U. S. Army, is designed to be used in connection with the Rodman pressure-gauge, for the purpose of determining the presence per square inch exerted within the bores of cannon and small arms by the ignition of powder. It may also be used for testing the tensile strength of materials or for measuring their compression within certain limits. The size of the specimens would necessarily have to be small. When used for either of the latter purposes, special forms of housings have to be made to fit between the guide-blocks. In testing for tensile strength, provision must be made to check the sudden reaction of the springs at the instant of rupture, by interposing a block of rubber, or some other yielding substance, in order to break the force of recoil.

This machine consists essentially of—1. The frame; 2. The springs; 3. The cylindrical casing; 4. The guide-blocks; 5. The screw; 6. The graduated scale. The frame is rectangular in form and made of cast-iron. It rests upon a wooden pedestal formed of two thick cheek-pieces into which a transverse piece of timber is mortised and securely held by two long wrought-iron bolts. The frame is fastened to this pedestal by four bolts, also of wrought-iron. The steel springs are comprised in two systems, or nests, of concentric spiral springs, consisting of three springs each. The outer is a left-handed spiral and has the greatest cross-section; the middle one is a right-handed, and the central a left-handed, spiral. The two systems are placed one above the other between the uprights of the cast-iron frame, with a thin steel plate between them. The cross-sections of all the springs are rectangular, that of the central ones being the least. They are inclosed by a hollow cast-iron cylindrical casing, concentric with but not touching them. This casing does not rise to the level of the nests by nearly three inches, to allow space for their compression. The lower guide-block has on its under surface a flat disk of iron with a diameter equal to the exterior diameter of the springs, which rests upon the upper base, in order to give a good bearing surface. These nests of springs are those used for the ordinary car-buffers, with the exterior and interior cylindrical surfaces turned smooth.

so that the springs of each system are concentric without being in contact. Each nest is 7.68 inches in length, measured on the axis. The lateral deflection of the axis of the entire system due to compression is obviated by using two systems, or nests, as described above, with a steel disk between them, and by grinding the limiting bases of the springs to plane surfaces perpendicular to their axes, and inserting small steel blocks under the tapering terminal ends of the spirals, thus insuring the rigidity and stability of position of the basal planes of each system of springs. This blocking up and squaring the ends, while diminishing the amount of their compressibility, allow the power applied to the screw to be transmitted more uniformly to the springs, as they come to a bearing almost simultaneously. The guide-blocks are two rectangular pieces of cast-iron, with planed surfaces, accurately fitted to move between the planed surfaces of the uprights of the frame. In front they are confined to their positions by steel side plates screwed to them, and projecting shoulders retain them on the rear side of the frame. The lower block rests on the upper set of springs, and carries a cylindrical cap of nickel-plated brass, which conceals that portion of the springs which projects above the cylindrical casing. This cap is slotted at the sides to allow it to slide up and down the frame. Its diameter is a little greater than that of the casing, to admit of its passing over the latter during compression. The upper guide-block is attached to the screw by a shoulder which turns easily in a recess in the let surface of the block, and is covered by a steel plate into its upper side flush with the surface, and held by six screws. The screw is of steel, 1.6 inches in diameter, with eight threads to the inch; it engages a female screw in the upper cross-piece of the frame. The motion of the screw is limited in the direction of the axis by a metallic collar attached to the newel just below the wheel. The power is applied to a cast-iron wheel attached to the upper end of the screw. The length of the screw and the position of the collar are so correlated that when the machine is not in use, should the screw, by accident or design, be depressed to its fullest extent, no initial tension can be brought to bear upon the springs, provided the housing and block have been removed from between the guide-blocks, as they invariably should be except when in legitimate use. A graduated scale 6 inches long, made of a small square steel bar, is attached to the frame by two small blocks. These blocks are slotted to receive the ends of the scale. A screw inserted through each block and into the ends of the scale-bar furnishes the means of a longitudinal adjustment. A small sliding-block upon the scale, whose upper plane surface serves as a pointer, has a toe projecting from one side to receive the pressure of the lower edge of the side plate of the lower guide-block during its descent. This index or pointer is held in any position on the scale by the action of a gib, whose pressure is regulated by adjusting screws. The scale upon its four sides is graduated into sixteenths, fiftieths, sixty-fourths, and hundredths of an inch respectively.

When the dynamometer is used for finding pressures, the appendages are: 1. The block; 2. The housing; 3. The copper block or disk; 4. The cutter; 5. The limit-gauge. The block is of cast-iron, planed and fitted by narrow overhanging lips to the upper surface of the upper guide-block. A pin projecting from the latter into a small hole countersunk in the bottom of the block centers it, and a corresponding pin set in its upper surface performs the same function for the housing, thus insuring the coincidence of the line of direction of the pressure with the axis of the screw. The housing is made of tempered steel, and its form and dimensions must conform to the object in view. Fig. 1 shows the usual form. The side screws (two on each side) project internally far enough to bring the edge of the cutter, when in position, upon a line one third of the width of the copper block from its longer side. By shifting the copper block, a second cut may be made in the same block. The widths of metal between the cuts and edges will be equal. The side screws serve to adjust the copper blocks in the housing and offer no serious obstruction to the flow of the metal, the places of contact being mere points. The position of the cutter is invariable, laterally. There is a stop on the back of the housing to facilitate the longitudinal adjustment of the copper block and cutter. The cutter-block is of tempered steel and is rectangular in shape. The cutting or *indenting* edge is an arc of a

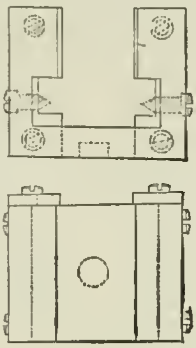


Fig. 1.

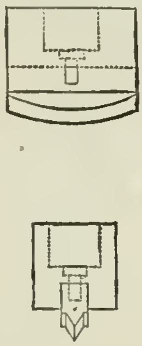


Fig. 2.


Fig. 3.

circle; the two surfaces whose intersections form the edge are two right cones with circular bases. The form and dimensions are shown in Fig. 2. The limit-gauge, shown in Fig. 3, consists of two parts. The lower part has on its upper end a screw which fits into a corresponding female screw upon the interior cylindrical surface of the upper part. This arrangement gives a longitudinal motion by which the length of the gauge can be adjusted. The planes of the ends of the gauge are parallel to each other. A collar on the upper part, and the base on the lower, are either milled or checked, for ease of turning while adjusting. See *Dynamometer* and *Pressure-gauge*.

BENTON THREAD VELOCIMETER.—A gravity instrument in which the weights are suspended by the tension of a cord, and it may be worked with common thread in place of the usual electro-magnetic currents. The principle involved in this arrangement is that the loosening effect of cutting a taut thread is transmitted to equal distances along the thread from the point of rupture, in equal, or sensibly equal, times. It is a principle that can be applied to others of the large class of machines for measuring small intervals of time. The peculiar advantages found in the use of threads over electricity are simplicity and cheapness of the apparatus, freedom from acid and water for the batteries, and the certainty and ease with which it can be operated by a single person, and that person the one who fires the gun.

Fig. 1 represents the front and end views of the Benton Electro-ballistic Machine, originally devised for the use of the Military Academy, and since modified and adopted by the Ordnance Department, for proving powder, etc. *a* is a bed-plate of metal, which supports a graduated arc, *b*. This arc is placed in a vertical position by means of *thumb-screws* and *spirit-levels* attached to it; and it is graduated into degrees and fifths, commencing at the lowest point of the arc and ending at 90°. *p p'* are two pendulums having a common axis of motion, passing through the center and perpendicular to the plane of the arc. The bob of the pendulum, *p'*, is fixed, but that of *p* can be moved up and down with a thumb-screw, so as to make the times of vibration equal. *m* and *m'* are two electro-magnets attached to the horizontal limb of the arc, to hold up the pendulums when they are deflected through angles of 90°. *s* and *s'* are pieces of soft iron attached to the prolongations of the suspension-rods, in such way as to be in contact with the lower poles of the magnets when the pendulums are deflected. *d* is an apparatus to record the point at which the pendulums pass each other, when they fall by the breaking of the currents which excite the magnets. It is attached to the prolongation of the suspension-rod, *p'*, and consists essentially of a small pin inclosed in a brass tube; the end of the pin near the arc has a sharp point, and the other is terminated with a head the surface of which is oblique to the plane of the arc. As the pendulums pass each other, a blunt steel point attached to the lower extremity of the suspension-rod, *p*, strikes against the oblique surface of the head of the pin, which presses the point into a piece of paper clamped to the arc, leaving a small puncture to mark the point of passage. An improvement to the foregoing consists in attaching to the pendulum, *p'*, a delicate bent lever, which carries on its point a small quantity of printer's ink; the pendulum, *p*, presses upon this lever, causing the point to touch the arc and leave a small dot opposite to the point where the pendulums pass each other. The magnets are also so arranged that they can be transposed from one pendulum to the other, thereby affording the means of correcting errors arising from inequalities of magnetic power, by taking a mean of two observations. *c c* and *c' c'* represent the wires which conduct the two electric currents to the magnets *m* and *m'*.

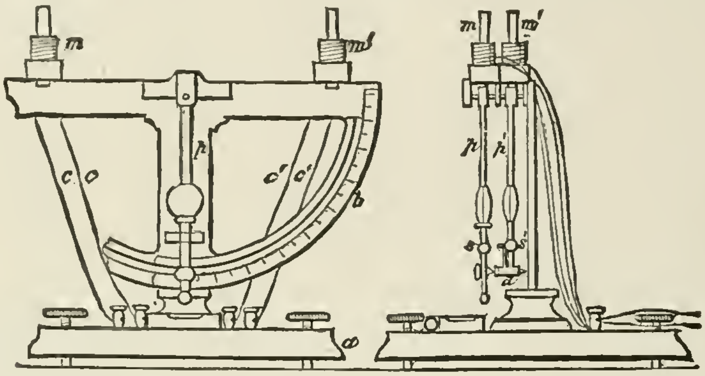


Fig. 1.

The targets, two in number, are designated as No. 1 and No. 2, in the order of their distance from the piece. *For cannon* the targets are similar in construction; each consists of a post fixed in the ground, to which are well secured two horizontal arms. A thread, *d d*, Fig. 2, is stretched vertically between these arms, to which is attached the thread leading to the pendulum at one side. The point of attachment of this thread should be a little below where the projectile cuts the vertical thread, and is shown at *b*. Both threads to the pendulum pass through the loops of the compressors, and are fastened to posts set in the ground, in such relative positions to each other and the pendulum that the compressors will sustain the pendulums when the threads are tightened, and will relax their hold when broken. When cannon are carefully aimed, the projectile will cut both vertical threads directly; but in the case of small-arms it is found difficult to insure the cutting of the thread of No. 2 target without a special arrangement. Target No. 1, for *small-arms*, consists of a piece of board with a vertical opening to serve as a rest for the muzzle of the gun. Across this opening, and directly in front of the muzzle, is stretched a short horizontal thread secured to two leather washers. The thread to pendulum No. 1 is drawn around the middle of the horizontal thread, and secured at the leather washer. The muzzle of the piece is in contact with the intersection of the threads, which should be a little below the center of the bore. The thread is cut the instant the bullet reaches the muzzle, and the other thread slackens, generally without breaking. Target No. 2, for small-arms, Fig. 3, is composed of

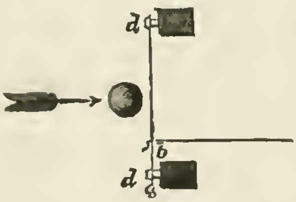


Fig. 2.

an iron target-plate, B, 1 inch thick, which swings freely on horizontal trunnions at its upper edge. The lower back edge of the plate rests lightly against the back of a sharp knife-blade, D, hinged at E. The thread, I, leading to pendulum No. 2 is wrapped around the slitted part in which the knife-blade operates, and fastened to the leather washer, F. C, C are two flat iron bars bolted to a post of wood let into the ground, and serve as supports of the trunnions of the target-plate, B. When the bullet strikes the plate, B, the knife-blade, D, is pressed backwards, cutting the thread, I, and releasing the pendulum. C and H are screens of boiler-plate to protect the thread and knife from fragments of the bullet. The target-plate, B, is made of tough wrought-iron about 6 inches wide, 6 inches deep, and 1 inch thick. The

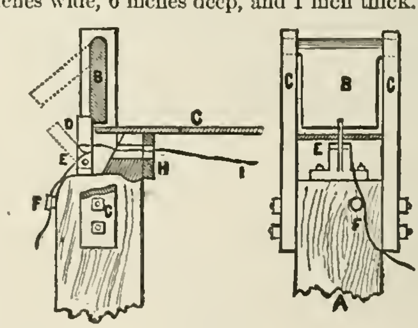


Fig. 3.

knife should be made as sharp as possible, so that a slight tap of the finger on the target-plate will suffice to cut the thread.

For use with small-arms, the graduated arc of the machine should be placed in or near the plane of fire; for cannon, the arc should be parallel to and at least 100 feet to one side of the plane of fire, beyond the jar due to the discharge, and in every case equidistant from the targets. If it be desired to use a table of calculated velocities, the distance between the targets must correspond to that used in the table; but any distance may be taken and the tabular velocity modified by multiplying it by the ratio of the actual and tabular distances. The machine and the targets having been located and the threads laid, the operator, before commencing to work, levels the machine by means of the thumb-screws and spirit-levels, and tests the pendulums and compressors to see that they work freely; then, 1st, deflects the pendulums; 2d, tightens the compressors and secures the threads at the targets; 3d, covers the point of the marker with printer's ink; 4th, fires the piece; 5th, notes the reading of the arc; 6th, wipes out the ink-mark. Assuming that each pendulum, whether held deflected by an electro-magnet or by a thread and compressor, begins to move at the instant the projectile cuts the target, then the interval of time between the rupture of the two targets will correspond to the difference of the arcs described by the pendulums up to the time of meeting. To determine a formula for the time that it takes for one of the pendulums to pass over a given arc, let l be the length of the equivalent simple pendulum, v the velocity of the center of oscillation, y the vertical distance passed over by this point, x the variable angle which the axis of the pendulum makes with the horizontal, and t' the time necessary for the point to pass over an entire circumference, the radius of which is l, with a uniform velocity v. We have

$$v = \sqrt{2gy}.$$

Substituting for y its value in terms of the constant angle of half-oscillation and the variable angle x, the above expression becomes

$$v = \sqrt{2gl \cos. (90^\circ - x)}.$$

The time t' is equal to the circumference of the circle, the radius of which is l, divided by the velocity v; again divide this by 360; we have the time of passing over each degree, or

$$t = \frac{2\pi l}{360 \sqrt{2gl \cos. (90^\circ - x)}}.$$

To determine l it is necessary to change the points of suspension from cylinders to knife-edges, in order to determine the time of vibration through a very small arc. The mean of 500 vibrations will be very near the exact time of a single vibration. Denoting this time by t'' and substituting it in the preceding expression for its value $\pi \sqrt{\frac{l}{g}}$, there results

$$t = \frac{t''}{180 \sqrt{2 \sin. x}}.$$

As t'' is constant for any one place, $\frac{t''}{180\sqrt{2}} = A$, will be constant, and we have $t = \frac{A}{\sqrt{\sin. x}}$. By assigning values to x, a table can be formed giving the times corresponding to different arcs. The length of the equivalent simple pendulum in all velocimeters is made 5.558 inches, and tables calculated on this length will answer for practical purposes in all altitudes and latitudes in the United States where they are likely to be used. To find the velocity for a given reading take the corresponding time from the table, double it, and subtract its logarithm from the logarithm of the distance between the targets. The remainder will be the logarithm of the required velocity. By constructing a "table of velocities" calculated for degrees and tenths of degrees, from 10° to 29° inclusive, and for the distance between the targets used, velocities may be readily obtained by inspection.

The peculiar advantages found in the use of this velocimeter are simplicity and cheapness of the apparatus, freedom from acid for the batteries, and the certainty and ease with which it can be operated by a single person, the one who fires the gun. If electricity be employed with this machine, two galvanic batteries will be required. These should be as nearly as possible of the same strength and constancy, in order that any remaining magnetism in the magnets may be as uniform as possible. The currents from the batteries pass to the electro-magnets and the targets, each magnet having its own battery and target; the circuit of each current must, however, include the *disjunctor*. This latter is a small auxiliary instrument by which the currents may be broken simultaneously. Each pendulum is held deflected through an angle of 90° by its electro-magnet and is released and allowed to oscillate when the current is broken by the rupture of its target, or by the disjunctor. The point at which the pendulums meet, when falling, is noted by the *marker*. This consists of a bent lever attached at the lower end of the inner pendulum. As the pendulums pass each other, an arm on the outer one presses upon the lever, drives it against the arc, and leaves thereon a dot made by printer's ink, carried on the point of the lever. The *error* of the machine is determined by making a rupture of the wires by the disjunctor, and observing the point of passage of the pendulums with reference to the zero of the arc. See *Chronoscope*.

BERDAN TELEMETER.—It is proposed with the Berdan range-finder, as with the majority of instruments intended for the same use, to determine the side of a right-angled triangle BAC whose base, CA, is known by measuring the angle at the apex. Let b be the base. One can measure on the side AB a certain number of distances, of which the constant difference is m, corresponding in range to *successive notches* of the sight. If $AB = c$ is the smallest distance, the following results: $c + m$, $c + 2m$, . . . and the greatest, $c + nm$. The angles at the apex corresponding are given by their tangents:

$$\text{tang. } B = \frac{b}{c};$$

$$\text{tang. } B_1 = \frac{b}{c + m};$$

$$\text{tang. } B_2 = \frac{b}{c + 2m};$$

. . . .

$$\text{tang. } B_n = \frac{b}{c + nm}.$$

One is able to measure in practice these different angles by prolonging to the rear of the point C the hypothenuse of each triangle as far as the arc of a circle described from the point C with a radius l. We obtain in this way the points 0 . 1, 2 . . . h, and the arcs 0D, 1D, 2D — nD, or X, X_1, X_2 — X_n, measuring the angles B, B_1, B_2 — B_n. If it is desired, for example, to measure some infantry distances:

$$C = 300 \text{ meters};$$
$$m = 50 \text{ meters};$$
$$c + nm = 1600 \text{ meters}.$$

If we take $b = 2$ meters and $l = 0.4^m$, we have

$$\text{tang. } B = \tfrac{2}{300} = 0.00666, \quad B = 22' 55'';$$
$$\text{tang. } B_n = \tfrac{2}{1600} = 0.00125, \quad B_n = 4' 17'';$$
$$\text{angle} (X - X_n) = B - B_n = 18' 38''.$$

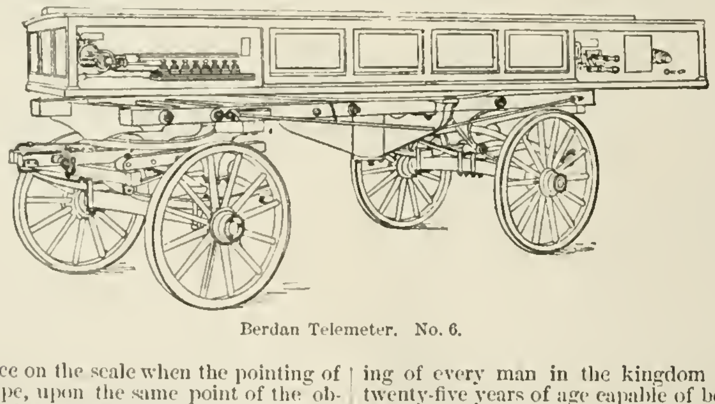
Upon a circumference whose radius is 1 this angle intercepts an arc of 1118×0.000004848, which is 0.00542; for a radius of 400 millimeters,

$$X - X_n = 0.00542 \times 400 = 2.168^{mm}.$$

These arcs are, moreover, sufficiently small to enable one to substitute for their lengths those of their tangents, and to form the following table without recourse to trigonometrical tables:

Distances in meters. $c, c + m, \ldots c + nm$.	Tangents. tang. $B, B_1, \ldots B_n$.	Arcs. $X, X_1, X_2, \ldots X_n$.	Differences. $X - X_1, X_1, X_2 \ldots - X_{n-1} - X_n$.
		Millim.	*Millim.*
300	0.006666	2.667	0.381
350	0.005714	2 286	0 286
400	0.005000	2 000	0.223
450	0.004440	1.777	0.177
500	0.004000	1.600	0.146
550	0.003636	1.454	0.121
600	0.003333	1.333	0.103
650	0.003076	1.230	0.087
700	0.002857	1.143	0.077
750	0 002666	1.066	0.066
800	0.002500	1.000	0.059
850	0.002353	0.941	0.053
900	0.002222	0.888	0.046
950	0 002105	0.842	0 042
1,000	0.002000	0.800	0.038
1,050	0.001905	0.762	0.035
1,100	0.001818	0.727	0.032
1,150	0.001739	0.695	0.029
1,200	0.001666	0.666	0 026
1,250	0.001600	0.640	0.025
1,300	0.001539	0 615	0.022
1,350	0.001481	0.593	0.021
1,400	0.001428	0.572	0.020
1,450	0.001380	0.552	0.019
1,500	0.001333	0.533	0.017
1,550	0.001290	0.516	0.016
1,600	0.001250	0.500	
			2.167

One sees definitely that while rapidly measuring the arcs X, X_1, X_2, the corresponding distance will be at the same time determined. Among instruments already known a great number measure, in the same way, angles by a single observation, unfortunately too long to be practically possible on the field of battle. The essential conditions are great rapidity and accuracy in connection with the graduation of the sight. The range-finder invented by General Berdan satisfies these conditions by reason of the advantages which it presents. So far it does not seem to be objected to in Germany, where it is very much appreciated, either by its net cost (about 25,000 francs) or by its large size, which it owes in part to its two telescopes, astronomical instruments of great power, about five feet long ($1^m.52$), and provided with object-glasses 4 inches ($0^m.10$) in diameter. Some improvements in details have been made in it, however, which have not so far been made public. The apparatus consists essentially of two telescopes, connected by a fixed base, one of which can be moved without altering the length of the base. This displacement can be measured by a micrometer which gives immediately the distance on the scale when the pointing of the second telescope, upon the same point of the object at which the first one is directed, is completed. The micrometer-screw which produces and measures the displacement of the movable telescope has a movement equal to the total arc $X - X_n$. It is provided with a large head or drum, the circumference of which is divided in n parts proportionately to the arcs $X - X_1$, $X - X_2$, . . . $X_{n1} - X_n$. Each division corresponds, therefore, to one of the distances c, $c + m$, $c + 2m$, . . . $c + nm$. General Berdan has recently modified his telemeter for garrison and sea-coast service, and constructed a new model intended for field and mountain artillery. This last instrument is constructed upon the same optical principle as that which was applied in the telemeter of great range. The inventor rightly thought that his first telemeter was too heavy for field and mountain batteries, and endeavored to make this instrument lighter, more easily handled, and cheaper. The telemeter represented in the drawing is the old instrument modified; it is called No. 6 in the series of General Berdan's essays. In this model the box can be turned in all directions independently of the wagon. The instrument has a fixed base of 4 meters; two telescopes of $1^m.50$, with object-glasses 90^{mm} in diameter, and a reckoner which indicates directly distances up to 10,000 meters. The author asserts that it only takes 30 seconds on an average to estimate distances, and that the errors of observation are less, even for movable objects, than the average error in range resulting from the precision of fire of artillery. This instrument, although more powerful than the one described previously, and more easily handled, in consequence of the rapidity with which the first telescope can be directed upon the object to be sighted, is still too cumbersome for service with field-batteries, and should be reserved for garrison and sea-coast batteries. Telemeter No. 7 is of smaller dimensions; it is quite portable. It has a base of $1^m.33$; the telescopes are $1^m.12$ long, and the reckoner is graduated up to 6000 meters. For transportation the telescopes are packed in the direction of the length of the instrument. The power of this telemeter is one half that of No. 6; one operation occupies about 30 seconds. The weight of No. 7 is only 70 kilometers (154 pounds), while that of No. 6 is about 1000 kilometers (2200 pounds). No. 7 is therefore suited to field and mountain batteries, as well as for observation on shipboard. General Berdan thinks that the very high price of his instrument ought not to be considered in the choice of a telemeter, in consequence of the advantages which result from the *exact* determination of distances. It is impossible, in his opinion, to construct a practical instrument smaller and cheaper, for he thinks it absolutely necessary to have a fixed base and a reckoner; now the fixed base being always tolerably small (4 meters at the most), involves necessarily the employment of powerful telescopes. See *Pratt Range-finder* and *Telemeter*.



Berdan Telemeter. No. 6.

BEREUNG.—A kind of Swedish militia, consisting of every man in the kingdom from twenty to twenty-five years of age capable of bearing arms.

BERG BARTHE.—A variety of battle-axe used in the seventeenth century. This arm was seldom used for war purposes, but mostly by miners on the festival-day processions of miners' corporations.

BERM.—Between the parapet and ditch of a field-fortification a narrow zone is usually left on the natural surface of the ground which is termed the *berm.* This is a defect in field-works, because it yields the enemy a foothold to breathe a moment, before attempting to ascend the exterior slope. It is useful in the construction of the work for the workmen to stand on; and it throws the weight of the parapet back from the scarp, which might be crushed out by this pressure. In firm soils the berm may be only from *eighteen inches to two feet wide;* in other cases, as in marshy soils, it may require *a width of six feet.* In all cases it should be *six feet below the exterior crest*—to prevent the enemy, should he form on it, from firing on the troops on the banquette. See *Field-fortification.*

BERNARD SYSTEM OF FORTIFICATIONS.—This system proposes a double enceinte covered by counterguards and ravelins, having high and low faces. The outer bastions can be isolated, after the enemy has opened a breach, by blowing up the flanks. Bernard proposes two other methods, which are based upon excellent principles.

BERNER RIFLE.—An early two-grooved rifle, firing a belted ball, and of which the Lancaster rifle is a modification.

BERSAGLIERI.—The name given to the Riflemen or Sharpshooters of the Italian army. After the disastrous campaign of Charles Albert against the Austrians in 1848–49, and the abdication of that monarch, his son, Victor Emmanuel, commenced a remodeling of the Sardinian army. One improvement, brought about by General Alessandro della Marmora, was the formation of a Corps of Bersaglieri. These were light active soldiers, dressed in a picturesque but serviceable dark-green uniform, and armed with long rifles. Two battalions of these Riflemen formed part of the Sardinian army during the Crimean War. On the 16th of August, 1855, they took part in the battle of the Tchernaya. During the Italian War of 1859 the Bersaglieri were engaged in many operations requiring dash and brilliancy. There are over 40,000 Bersaglieri in the regular army.

BESIEGE.—An army, to undertake the siege of a fortress, must have superiority in the field, so that while some of the corps are occupied in besieging the place, others are employed in *covering* this operation, or in repulsing the enemy whenever he endeavors to succor the place. The army covering the siege is called an *Army of Observation*, and that which endeavors to give aid to the place is called the *Succoring Army.* The *Besieging Army* is that which, protected by the army of observation, throws up all the works necessary to take the place, such as trenches, batteries, etc. It begins its operations by investing the fortress; that is, it will advance with the greatest secrecy and rapidity, and occupy positions on every side, to cut off all communication with the adjacent country, and confine the garrison entirely to their own resources. The positions thus occupied are strengthened by field-works, and a sure communication is kept up between them. It is absolutely necessary to invest the fortress attacked, so as to prevent the garrison holding any intercourse with the neighboring country; for if this precaution be not taken, the defenders will be able to draw fresh supplies of men, provisions, and ammunition from the country, increasing greatly the duration of the siege, and reducing the chances of ultimate success. At the late siege of Sebastopol, the ground being intersected by the inlet of the harbor of Sebastopol, the allied army was unable to complete the investment. Thus the fortress on the northern side was left open to receive all the reinforcements of men and *materiel* which could be furnished by the resources of Russia. Fresh officers, fresh troops, fresh provisions were continually poured in; the defenses were enlarged and multiplied; and the besiegers, attacked in their own lines, held at one period a very critical position. The siege was thus prolonged beyond that of any other of modern times, and success was ultimately attained by a loss of men and *matériel* altogether unprecedented. Ground was broken on the 10th October, 1854, and on the 10th September, 1855, the Russians, having sunk their ships, retreated from the southern to the northern side of the harbor, leaving the works on the southern side in the hands of the allies, exactly eleven months after the commencement of their attack. A place may sometimes be reduced by investment or blockade alone, and where it is possible suddenly to blockade a place ill provisioned and filled with a numerous garrison and population, it may be the most ready and bloodless mode of proceeding. Indeed, many other circumstances may render it desirable to endeavor to reduce a place by blockade. When the defenders have been driven within their works, and the place invested, the ground before the fronts to be attacked is carefully examined, and the most suitable situations selected for the park of artillery, and the Engineers' park: the former to receive all the ordnance stores and ammunition; the latter all the Engineers' stores and materials to be used in the construction of the trenches, batteries, etc. These parks should be placed in secure localities, behind the slopes of hills or in ravines, beyond the general range of the guns of the fortress, but with a ready access to the trenches and batteries of attack, for the use of which they are formed.

The artillery and Engineer parks having been duly established, and an adequate supply of ordnance, ammunition, and materials collected in them, for a week's or ten days' consumption, the actual work of the siege begins. The objects of the besiegers are three: 1st. By a superior fire of artillery to dismount the guns and subdue the artillery-fire of the place. 2d. To construct a secure and covered road by which his columns may march to assault the defensive works, so soon as they are sufficiently destroyed to justify the attempt. 3d. To breach or batter down the escarp revetments of the fortress in certain spots, causing the fall of the rampart and parapet supported by them, and thus exposing the interior of the place to the assaulting columns. Now, before any means can be taken to attain any one of these objects, a strong force must be placed under cover, close at hand to the spots on which the necessary operations are to be commenced, whose duty it is to repel any sortie of the enemy, and drive back any parties which issue from the place to destroy or interrupt the works of the attack. The cover provided for this guard of the trenches is usually a trench and parapet called the first parallel, formed around the whole of the fronts attacked: its distance from the advanced-works has usually been between 600 and 700 yards. In the late siege of Sebastopol, the first parallel was opened at a distance of 1200 yards; and doubtless, in future sieges, owing to the increased range of fire-arms, the first parallel will seldom be less, and may probably be considerably more distant. This parallel is formed by approaching the place secretly in the night with a body of men; part carrying intrenching-tools, and the remainder armed. The former dig a trench in the ground parallel to the fortifications to be attacked, and with the earth excavated from the trench raise a bank on the side next the enemy, while the latter remain under arms, usually in a recumbent posture, in readiness to protect the working party, should the garrison sally out. During the night, this trench and bank are made of sufficient depth and extent to cover from the missiles of the place the number of men requisite to cope with the garrison, and the besiegers remain in the trench throughout the following day, in despite of the fire or of the sorties of the besieged. This trench is afterwards progressively widened and deepened, and the bank of earth raised till it forms a covered road, called a parallel, embracing all the fortifications to be attacked; and along this road, guns, wagons, and men securely and conveniently move, equally sheltered from the view and the missiles of the garrison. So soon as the first parallel is established, the Engineers select positions for the batteries to silence the defensive artillery. In the positions of these batteries lies one of the principal advantages of the besiegers. Batteries of guns and mortars are now constructed a little in advance of this parallel, in positions such that their guns enfilade all the faces of the works attacked. The crest-lines of these batteries are therefore made perpendicular to the prolongations of the faces of the ravelins and bastions of the fronts attacked, and so great is the advantage to the besieger arising from such positions of his batteries, that with an equal or sometimes smaller number of guns he is able speedily to subdue the artillery-fire of the defense. These enfilading batteries on the first parallel should be completed and ready to open fire on the third morning after breaking ground.

After the fire of the defensive artillery has been sufficiently subdued, the approaches are commenced. These, like the first parallel, are trenches dug in the ground and protected by a parapet formed of the excavated earth, thrown up on the side of the enemy's works. The approaches are made on the capitals of the ravelins and bastions attacked, but not in a straight line directly towards the salients, as in that case they could be enfiladed from end to end, but in a zigzag direction, alternately to the right and to the left of the capitals, in such a manner that their prolongations fall clear of the fortress, and the possibility of enfilading them is entirely removed. The heads of these approaches are pushed forward by small parties of men, who, from their great numerical inferiority, are quite unable to contend with sorties issuing from the place. To prevent the repeated destruction of the approaches, and the continual loss of the working parties engaged in their construction, a guard of sufficient strength must always be stationed within a distance from these works not exceeding the distance of these works from the covered-way of the place: so that a sortie issuing from the place for the purpose of destroying the approaches may be met and repulsed by the guard of the trenches before they can have time to carry their object into effect; and as the approaches themselves, from their limited dimensions, afford no accommodation for a guard of the trenches, a parallel must always be established at least as near to the head of the approaches as the heads of approaches to the covered-way of the place. It may then be considered a general principle of the attack that a new parallel or place of arms becomes necessary when the approaches have advanced half-way between the last-formed parallel and the covered-way of the fortress. So soon, therefore, as the approaches have advanced half the distance between the first parallel and covered-way of the fortress, a second parallel must be established to accommodate a guard of the trenches, or the working parties at the heads of the approaches will be liable to be swept off by parties of cavalry issuing from the covered-way, before aid can reach them from the first parallel. The approaches are then pushed forward, parallels being made according to the principles just laid down, wherever required, until they reach nearly the crest of the covered-way. Here a trench of greater magnitude is formed, and in it batteries of heavy guns are constructed to silence the remaining artillery of the defense, and to breach in certain selected spots the escarp revetment-wall, thus destroying the formidable obstacle to assault presented by the high perpendicular sides of the ditches of the fortress. The order for the assault is given when the breach has been rendered practicable by the overthrow of the parapet upon the ruins of its walls; and after a gallery has been opened for descending into the ditch, across which a good epaulement has been made joining the breach to the gallery. The troops for the assault are held in the ditch, in the crowning of the covered-way, and in the third parallel. These detachments are to sustain each other and to do it with strong arms. At the concerted signal, the first detachment mounts the breach, driving back the defenders, and seeking to establish itself firmly upon the height by constructing with gabions a lodgment in the angle of the bastion. This is a little intrenchment, called by the French *nid de pie*, which crowns the breach, and under shelter of which the soldiers fire upon all who present themselves. The sappers are charged with its construction, and, in sufficient numbers for this purpose, accompany the assaulting party, each carrying a shovel, a pickaxe, and a gabion. The second detachment aids the first in surmounting the breach, and relieves it if the struggle is obstinate. The third detachment lines the trenches upon the glacis, and sweeps with its fire the parapets and top of the breach, and wherever else there is resistance; but care must also be taken, before coming to close quarters, to facilitate the assault by directing upon the work attacked as many pieces of artillery as possible. When the close combat begins, the artillery ceases, as it would otherwise fire upon friend and foe.

Frequently the taking of the first works brings about the surrender of the place, but again it often happens that the irresistance is but a foretaste of the obstinate defense to be made, and it is necessary to grasp, step by step, the fortifications of the besieged. Sometimes, again, the possession of the ramparts does not put an end to the fighting, but courageous citizens, willing to sacrifice their property to the honor and independence of their country, dispute inch by inch the possession of the streets and houses. The defense of Saragossa in 1808 is a heroic instance of such devotedness. The Spaniards, after losing their fortifications, sustained during twenty-three days attacks in streets and from houses. They capitulated for want of powder, and only after the enormous loss of fifty-four thousand persons of all ages and sexes. A Commanding Officer *defending the approaches of a fortress* threatened by armed enemies declares it in a *state of siege*, and from that moment martial law prevails; or, in other words, the military authority alone governs. Everything is brought into the place necessary for defense, in the shape of wood, fascines, gabions, animals, grain, and eatables of all kinds. All useless mouths are sent out of the place, and those inhabitants who remain are required to provide themselves with wheat, dried vegetables, oil, salt meats, etc., for many months, in order that the garrison may not be obliged to share their provisions with them. The place is put in a state of defense by arming and repairing the fortifications, planting palisades, clearing away the incumbrances in the communications, etc., etc. When the garrison is sufficiently numerous, and that is the case here supposed, it guards against being entirely shut up in the place, by disputing all approaches. Positions are taken in advance of the suburbs, and, far from destroying the suburbs as a smaller garrison must do, they should be covered by intrenchments, in the double aim of preserving them, and sparing the rear as long as possible. Besides the preceding intrenchments, advantageous points are selected for solid redoubts and small posts. The most exposed passages are closed by abatis or deep cuts. Walls are pierced with embrasures, the different stories of houses made defensible, and all means whatsoever resorted to that can prolong the defense. Upon a field of battle thus prepared a long resistance may be expected, and the attacking force will experience great losses before they can open their trenches and begin the ordinary labors of the siege. Perhaps even during this exterior struggle political events or other warlike operations may extricate the garrison from the impending siege, and its glorious struggle will then have freed the place committed to it from many horrors. If the moment at last comes when it is necessary for the garrison to shut itself up, then follows that series of operations properly called a siege. The defense has a thousand means of prolonging its duration, because his exterior defense has given time to prepare them. Knowing the point of attack indicated by the first operations, the defense will have redoubled his intrenchments. The garrison will have been made warlike by frequent combats.

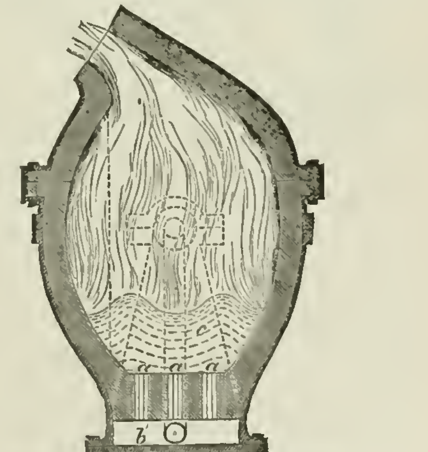
It occupies, it is true, a post hard pressed, but its force is the more concentrated from that cause, and is still imposing notwithstanding the losses that it has experienced. It is by *sorties* that we retard the operations of the besiegers. Large sorties are executed by numerous corps, and are generally made by day to avoid confusion. Small sorties are made at night, and consist of but few men. The first are designed to overthrow the trenches, fire the batteries, and spike the pieces, and they are consequently always followed by a sufficient number of workmen, provided with the necessary instruments. The smallest sorties are only directed against the workers of the sap; they present themselves unexpectedly, and frequently drive away the workmen and break up the gabions. The sap thus interrupted progresses but slowly.

Defensive mines are also a powerful means of prolonging the defense, as they force the besieger to make works that require much time in their preparation. As soon as the point of attack is known the besieged prepare under the glacis chambers of mines, which threaten the batteries of the besieger and constrain him to dig under the ground. The defense has in this subterranean war a great advantage, as he expects the attack in galleries previously prepared. The attack has no other resource than to prepare his chambers at a great distance in order to destroy those of the defenders, and for this purpose *globes of compression* are employed. These overcharged chambers, however, require a great deal of powder, and also much time for their preparation. The besieged has also an advantage in the defense of breaches, because the attacking force may be surrounded, and can only reach their object by a narrow and difficult ascent. In defending a breach, therefore, all the energies of the defense should be brought into action. Preparations should be made in advance for this period of the siege, and some pieces of artillery should be carefully preserved, to arm at the moment of the assault these works which take in flank and reverse the columns of attack. At the top of the breach loaded shells are kept ready to roll down upon the assailants; a large fire should be lighted at the foot of the breach, and kept up by fagots. Or, if the enemy has only partially beaten down the wall, the foothold may be cleared away during the night in such a manner as to make the breach impracticable. Mines may be dug under the ruins by which the assailants may be overthrown. Long arms, as pikes, may be given to the soldiers who defend the breach, and those in the front ranks may be protected by cuirasses. If the work attacked has much capacity, reserves may be held in the interior to charge the enemy when he shows himself, and cavalry may also be brought up at this decisive moment. Such are, in general, the steps to be taken to defend a work; but success will at last depend upou the character, firmness, and skill of the Governor, and upon the intrepidity of his soldiers. The army of observation ought not to be too far from that engaged in the siege, because it may be necessary to call for reinforcements from the latter, and they should be able to return to their camps after the action. Such aid furnished at the opportune moment is precious, and may contribute powerfully to defeat or repulse an enemy. When Napoleon covered the siege of Mantua he did not confine himself to drawing battalions from the besieging army, in order to fight the numerous troops striving to surround him, but he marched the whole besieging army, and uniting it with the army of observation, he gained the celebrated battle of Castiglione. Besides, if the army of observation be too far off, there is nothing to prevent the enemy from unexpectedly attacking the besieging army, which, occupying a long line of investment, is rarely in a condition to repulse such an attack, and may therefore, without aid, be compelled to raise the siege, with the loss of ordnance and other material. General rules cannot be laid down for the position to be taken by an army of observation. It must possess mobility of action, and seek concentration as much as circumstances admit. It must not consider itself tied to the besieging army, and yet be always ready to succor the latter as well as repel a succoring army: conditions which demand much consideration, and which will be fulfilled only by varying dispositions according to circumstances. See *Siege*.

BESSEMER SHOT FOR SMOOTH-BORES. — The plan of this projectile is similar to that of the *Mackay*. Channels formed in the exterior of the projectile conduct the powder-gas to the front. The forward ends of these channels are sharply inclined so that the gas escapes nearly at right angles with the bore, and thus causes the shot to *recoil* in an opposite direction.

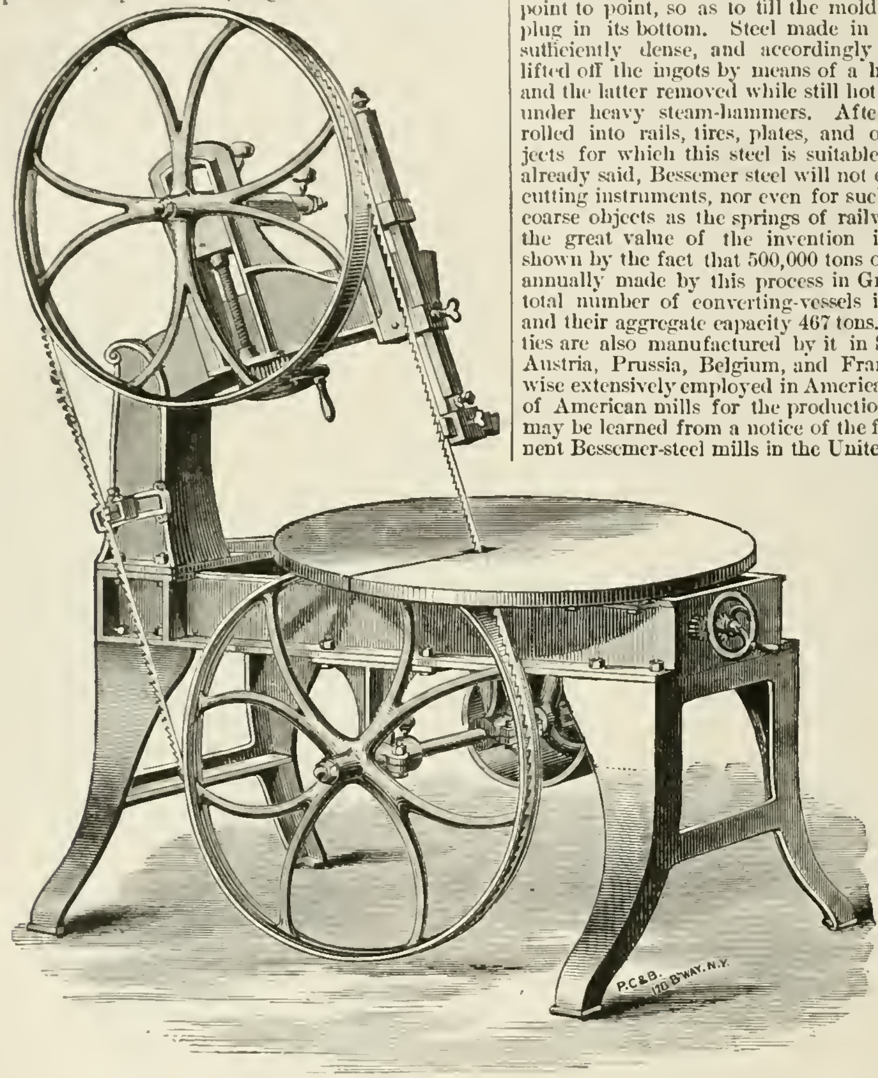
BESSEMER STEEL.—The boldest and most noted attempt which has yet been made to improve on the older methods of making both malleable iron and steel is that of Mr. Henry Bessemer, whose process was patented in 1856. Bessemer's first idea was to blow air through molten cast-iron till the whole of the carbon was oxidized when malleable iron was required, and to stop the blowing when a sufficient degree of decarburization was effected in order to produce steel. He has hitherto failed to produce malleable iron of the least service by his process, so that, as a metallurgical operation, it is at present confined to the manufacture of steel. But neither can serviceable steel be made by the plan first specified by Bessemer, except from the best charcoal-iron, such as the Swedish. In England, where charcoal-iron is not used for this purpose, the process can only be successfully conducted by first oxidizing the whole of the carbon and silicon, and then restoring the proper amount of carbon by the addition of a small quantity of a peculiar cast-iron of known composition, called *spiegeleisen*. Moreover, until recently hæmatite pig was the only kind of English iron which could be employed, as that made from clay ironstone contained too much phosphorus and sulphur; but by the Thomas-Gilchrist modification of the Bessemer process impure ores can now be employed.

The various steps in the Bessemer process, as at present conducted, are as follow: Pig-iron is melted either in a cupola or reverberatory furnace, and run



Converter, on Trunnions.

in the liquid state into a converting-vessel, such as is shown in the drawing, where *a*, *a*, *a* are tuyeres; *b*, the air-space; and *c*, the melted metal. This converter, or "kettle" as it is called in Sheffield, is of wrought-iron, lined either with fire-brick or with a siliceous material called "ganister," and is suspended on trunnions, so as to admit of its being turned from an upright to a horizontal position by means of hydraulic apparatus. The capacity of a converter varies from three to ten tons. In the bottom there are seven tuyeres, each with seven holes of one-half inch in diameter, through which atmospheric air is blown with a pressure of 15 to 20 lbs. per square inch by a blowing-engine. The molten iron



Bevel Band-saw Machine.

in the converter is therefore resting, from the first, on a bed of air, the strength of the blast being sufficient to keep it from falling through the tuyeres into the blast-way. During the blowing off of the carbon at this stage, a striking and magnificent effect is produced by the roar of the blast, and the volcano-like shower of sparks and red-hot fragments from the mouth of the converter, as well as by the dazzling splendor of the flame. In about 15 or 20 minutes the whole of the carbon is dissipated. The first " blow" being over, the converter is lowered to a horizontal position, and presently a red stream of molten spiegeleisen is run into its mouth, till it amounts to from 5 to 10 per cent of the whole charge. As already stated, the spiegeleisen restores the proper amount of carbon to produce steel; and after it is added, the blast is again turned on for a few minutes to secure its thorough incorporation. There is a circular pit in front of every two converters, with a hydraulic piston in its center, and on its counter-poised arm a large ladle is hung, so that it can sweep the whole circumference. Round this the ingot-molds are arranged, and the hydraulic machinery is so conveniently planned that, simply by moving levers, a man standing on a small platform can empty the contents of the huge converters into the ladle, raise or lower the ladle itself, and turn it round from point to point, so as to fill the molds by means of a plug in its bottom. Steel made in this way is not sufficiently dense, and accordingly the molds are lifted off the ingots by means of a hydraulic crane, and the latter removed while still hot, and condensed under heavy steam-hammers. After this they are rolled into rails, tires, plates, and other heavy objects for which this steel is suitable. Although, as already said, Bessemer steel will not do for tools and cutting instruments, nor even for such comparatively coarse objects as the springs of railway wagons, yet the great value of the invention is unmistakably shown by the fact that 500,000 tons of steel are now annually made by this process in Great Britain, the total number of converting-vessels in use being 91, and their aggregate capacity 467 tons. Large quantities are also manufactured by it in Sweden, Russia, Austria, Prussia, Belgium, and France. It is likewise extensively employed in America. The capacity of American mills for the production of this metal may be learned from a notice of the following prominent Bessemer-steel mills in the United States.

Name.	Place.	When Opened.	Converters. No.	Converters. Tons.
Albany & Rensselaer Iron and Steel Co...	Troy, N. Y.	Feb., 1865.	2	7
The Pennsylvania St'l Works......	Baldwin Sta.Pa	June, 1867.	2	6½
Cleveland RollingMills	Cleveland, O.	Oct., 1868.	2	6
Cambria Iron Co......	Johnstown, Pa.	July, 1871.	2	5
Union Rolling Mills...	Chicago, Ill.	July, 1871.	2	6
North Chicago Rolling Mills..........	Chicago, Ill.	April, 1872.	2	6
Joliet Iron and Steel Works.........	Joliet, Ill.	March,1873.	2	6¾
Bethlehem Steel W'ks	Bethlehem, Pa.	Oct., 1873.	2	7
Edgar ThompsonSteel Works	Pittsburg, Pa.	Sept., 1875.	2	7
The Lackawanna Steel Works	Scranton, Pa.	Oct., 1875.	2	5
Vulcan Steel Works...	St. Louis, Mo.	Sept., 1876.	2	7

See *Iron* and *Steel*.

BETON.—A French term for concrete. It is much used in permanent fortifications. *Béton aggloméré* is a species of concrete invented by M. Coignet. This is used in building arches, aqueducts, cellar-walls, etc. It differs from ordinary béton, having much greater strength and hardness—qualities derived from the ramming to which it is subjected. See *Concrete*.

BETRAY.—To deliver perfidiously any place or body of troops into the hands of the enemy; to discover that which has been intrusted to secrecy.

BETTY.—An ancient machine used for forcing open gates and doors. See *Petard*.

BEVEL BAND-SAW MACHINE.—A machine designed to avoid the instability of inclined tables supported by siegments, pivots, etc., and the difficulties encountered in holding and guiding work upon such tables. The saw is inclined, and the table simultaneously set to correspond with the inclination, by turning a single hand-wheel, it being unnecessary even to clamp the parts in place, as all remain locked in any position in which they are left. When a varying bevel is desired on work, it can be easily produced by turning the hand-wheel while the work is being fed to the saw.

The drawing shows the form of the machine used in the arsenals, which combines all the general features of the band-saw machine—having tension spring; rubber-covered wheels; adjusting-screw for inclining the upper shaft, accessible to the operator from his position in front of the machine, and so arranged that the adjustment can be made while the wheels are in motion; and self-oiling loose pulley. The machine is suitable for general work as well as for bevel sawing. For the latter it will be found of great value in carriage-factories, dock-yards, and for pattern-making.

The weight of the machine is about 1875 pounds; the diameter of the wheels, 40 inches; the total height, 8 feet; the width, 6 feet; the depth, 2¾ feet; the height of the sawing space, 15 inches; the tight and loose pulleys, 16 inches diameter, 4 inches face. The speed is 400 revolutions per minute. See *Band-saw Machine*.

BEVELED HANDSPIKE.—A handspike made of wood, the end of which is sloped off at an obtuse angle.

BHEESTIE.—An Indian term for a water-carrier. Bheesties are attached to all regiments in India, whether in barracks or on the march.

BHIL.—A native tribe in Central India, friendly to the English, which has done good service in suppressing the predatory habits of its neighbors. In common with other hill-tribes, the Bhil are supposed to have been aborigines in their region. They are of dark complexion and diminutive stature, but active and capable of enduring much fatigue. It is with much difficulty that they are reconciled to the life of agriculturists.

BHOOSA.—An article of forage fed to bullocks in India. It is a finely-chopped straw, 14 pounds of which with 6 pounds of grain constitute the ration.

BIACOLYTES.—A military organization in the Grecian Empire, whose duty was to prevent the committal of any excesses against life or property. Their service was analogous to that of the French Gendarmes.

BIANCHI DENSIMETER.—The density of the smaller-grained gunpowder is found by the *Bianchi densimeter*, which consists of a strong glass vessel provided with stop-cocks at each end. The lower end can communicate with a cistern of mercury, and the upper end with an air-pump. This vessel is attached to the apparatus and filled with mercury by exhausting the air from it; both stop-cocks are then closed. The vessel is then removed, weighed (suppose W the weight found), and emptied. One hundred grams of powder are then put in, it is again attached to the apparatus, and mercury is forced in by atmospheric pressure; the stop-cocks are again closed, and the vessel is detached and the weight (w) found. Then if S and d are the densities of the mercury and gunpowder respectively at the time of the experiment,

$$d = \frac{100S}{W - w + 100}.$$

See *Densimeter* and *Mallet Densimeter*.

BIBAUDIERS.—A name anciently given to the foot-soldiers armed with *cranequins*.

BIBAUX.—In ancient times, soldiers who fought on foot with cross-bow and lance. Also written *Petaux*.

BICKER.—A word formerly used in the sense of to skirmish; to fight off and on; to make repeated attacks.

BICKFORD FUSE.—An English patent fuse intended for miner's use. It consists of a cylinder of gunpowder or other explosive matter covered by a double layer of cord and varnished. A similar fuse covered with a water-proof composition was designed for submarine blasting. See *Fuse*.

BICOQUE.—A term used in France to signify a place ill fortified and incapable of much defense. It is derived from a place on the road between Lodi and Milan, which was originally a gentleman's country-house surrounded by ditches. In 1522 a body of imperial troops were stationed in it, and stood the attack of the whole French army, during the reign of Francis I. This engagement was called the Battle of Bicoque.

BICORNEURS.—An ancient name given to the militia of Valenciennes.

BIDARKEE.—A skin-boat of peculiar construction, used by the Aleuts; light and portable.

BIDAUTS—BIDAUX.—An ancient French corps of infantry; according to some authorities they were armed with two javelins.

BIGA.—A Roman term applied in ancient times to vehicles drawn by two horses abreast, and commonly to the Roman chariot used in processions or in the circus. In shape it resembled the Greek war-chariot—a short body on two wheels, low and open behind, where the charioteer entered, but higher and closed in front.

BIGHT.—The name applied to the bent or doubled part of a rope. Thus, one anchor may "hook the bight" of the cable of another, and thereby cause entanglement. In geography, bight has much the same sense as "bay."

BIGLES.—A military corps of Rome, whose particular duty was to furnish sentinels; the bread which these troops received was called *bigliaticum*.

BILBO.—1. A flexible-bladed cutlass from Bilboa. —2. A form of fetters for prisoners, named from Bilboa, Spain, where they were manufactured in large quantities and shipped on the vessels of the Spanish Armada. Bilboes consist of long bars or bolts of iron, with shackles sliding on them, and a lock at one end. When an offender on shipboard is put "in irons," it implies that bilboes are fastened to him, more or less ponderous according to the degree of his offense. The bilboes clasp the ankles in some such way as handcuffs clasp the wrist.

BILBOQUET.—A small 8-inch mortar, whose bore is only half a caliber in length. It throws a shell of 60 pounds about 400 toises.

BILDARS.—A name given to a certain class of natives in India who are entertained as a part of the establishment of a camp or of a siege-train on the march, for the purpose of clearing the camp of filth and dirt, or cutting down brushwood in and around the camp.

BILL—BROWNBILL.—The main offensive weapon of English infantry until the substitution of fire-arms; a two-edged, sickle-shaped knife or sword, weighing from 9 to 12 pounds, on a handle 3 or 4 feet long, and wielded with both hands. It had terrible power, sometimes taking off a person's head or cutting a man in two in spite of the strongest armor. It was also called a "glaive." The bill or bill-hook, under the name of *falx* or *falcula*, was a common weapon among the Romans. A similar implement was used by the Greeks. The figures of Perseus and Saturn are represented thus armed. With this weapon Jupiter wounded Typhon, and Hercules slew the Lernæan Hydra.

BILLED.—A term exclusively confined to the Foot-guards. It means that a man's name is placed in the list or bill of those who are to undergo drill and confinement to barrack. Hence a "billed man," "seven days' bill," "billed up," etc.

BILLET.—1. A document requiring a householder to receive a soldier or soldiers, including officers, with their horses. Only innkeepers and licensed victualers are liable to have troops billeted on them. See *Billeting*.—2. In Heraldry, billets are small oblong figures, sometimes taken to represent bricks, but more commonly *billets-doux*. The latter interpretation, which is that of Guillim, is generally adopted by English heralds, and is supported by the authority of Colombiere. The former again, which has the *Trésor Heraldique* and Sir George Mackenzie on its side, is further strengthened by the fact that in German they are called *Schindeln*, shingles.

BILLETING.—A mode of provisioning and lodging soldiers when not in camp or barrack. It is one of the many vexed questions connected with the organization and administration of the British army. When in camp or barrack, the soldier is supplied with hot food daily by the Commissariat Officers; or rather, with undressed food, and the means for cooking it. But when it is necessary to keep soldiers for one or more days in a town unprovided with barracks, a difficulty occurs which has never yet been properly surmounted; a burden is sure to rest on some one who is unwilling to bear it. In early times, monarchs were often wont to quarter their troops on the monasteries. In later times, the soldiers often compelled the inhabitants of towns to receive and support them; and the authorities were either unable or unwilling to prevent this. The Mutiny Act, passed for the first time in 1689, put a stop to this pernicious practice, by declaring that no housekeepers should be compelled to accommodate soldiers except on some recognized and fairly administered system. The Chief Civil Magistrate of a town, on requisition from the military authorities, quartered the soldiers on the inhabitants as fairly as he could. This continued in England until 1745, when all kinds of persons were exempted from this burden except certain traders; and the new system has been maintained with minor alterations ever since. The alteration was not made in Scotland until 1857. At present, the persons liable to have soldiers billeted on them are the keepers of public-houses, hotels, inns, ale-houses, beer-shops, wine-shops, spirit-vaults, livery-stables, and such-like licensed houses. There are certain exceptional cases provided for; and in and near London there are special regulations concerning the billeting of the Guards; but the general rule is as here stated. The persons liable are bound to accommodate soldiers, under a system that may be described in a few words. When troops are on the march from one barrack or station to another, and cannot cover the distance in one day's railway or foot traveling; or when they are to remain for a few days in a town unprovided with barrack accommodation, or where the barracks are already occupied—the Commanding Officer sends previously to the Chief Civil Magistrate, and demands *billets* for a certain number of men for a certain time. The Magistrate has a list of all the houses subjected to the billeting system, and he quarters the men on those houses as fairly as he can. Rules are laid down to prevent the Magistrate from billeting too many soldiers on one house; any excess in this way is remediable at the hands of a Justice of the Peace. On the evening before the arrival of the troops, two or three Non-commissioned Officers enter the town, and present an order for the delivery of the billets to them, in order that no delay may arise when the main body enter. After the arrival, the soldiers go to the houses on which they are billeted: all those belonging to one company being quartered as near together as may be, for convenience of muster; and the sick are billeted near headquarters. The licensed victualer, or other person, is bound to provide each billet-holder with food, drink, bed, and accommodation, either in his own house or somewhere near at hand. A specified sum of 10*d*. per day is allowed for this; or, under other circumstances, a trifling sum per day is allowed for fire, candles, cooking-utensils, salt, and vinegar. The sum per day allowed for hay and straw for a horse varies with the price of forage. The officers visit the houses, to see that the men really have one hot meal per day, instead of taking the value of it in money. The soldier may demand facilities for cleaning his arms and accouterments. The financial officer of the regiment makes the payments. There are often unpleasant disputes between the innkeeper or others, on the one side, and the officers of the regiment on the other, concerning the occupancy of the "best room," and on minor details. The militia are frequently billeted like the regulars. There being many untoward circumstances connected with this system, a Committee of the House of Commons, in 1858, sought how best to remove them. In their report, the Committee could not recommend the cessation of the billeting system altogether, but they pointed out certain possible ameliorations; and since that, by camping out the troops and other means, great efforts have been made to reduce billeting to a minimum. In the United States, the law declares that no soldier shall in time of peace be quartered in any house without the consent of the owner, nor in time of war but in the manner to be prescribed by law.

BILLETTE FUSE.—This fuse consists of a wrought-iron fuse-plug to which is attached the explosive apparatus. The plug is screwed into the eye of the shell, stopping it completely, the rest of the apparatus being inside the shell. In two side-channels are fixed by friction, by means of pieces of parchment, two small tubes of hard wood, one filled with chlorate of potassa, the other with sulphuret of antimony. Through these tubes pass two hard woolen cords, terminated at the upper ends by rubbers of copper. The other ends pass down through the cup and breaker of the fuse, and are tied together in a groove of the latter. In order to load the side-channels, they are left open at the bottom; that part of the apparatus being afterwards closed by means of the two halves of a hollow truncated cone, which are fixed to the body of the fuse by means of a screw. These half-envelopes are made of bronze, and leave between them two openings through which the flame is transmitted to the charge. The breaker is fixed to the cup by means of a steel screw through its center. The shells with which these fuses are used are fixed to sabots, the fuse being placed in the hollow and exactly in the axis of the sabot. When the shell strikes, the shock breaks off the steel screw connecting the cup and breaker at the point where they join; the weight of the breaker and strength of the screw being so regulated as to insure this effect. The weight and motion of the breaker act on the cords, producing the deflagration of the fulminates.

BILL-HOOK.—An intrenching tool used for cutting down and clearing jungle, branches of trees, stuff for gabions, fascines, etc. The bill-hook is much used in European armies, the pioneers of infantry always being provided with them. See *Bill*.

BILL OF LADING.—Officers of the Quartermaster's Department in charge of the transportation of public property issue bills of lading for the same. When transportation is required from one distant point to another, or over more than one road forming a through line, they ascertain from the proper representatives of the through line the lowest through rate, or any special rate less at which the transportation will be performed and cause the same to be inserted in the bill of lading. The following is a form of bill of lading as used in the United States Army:

No. . MARINE.

ORIGINAL BILL OF LADING.

————, 18—.

Received from ——, United States Army, on board of the —— of ——, whereof the undersigned is master or agent for this present voyage, now lying in the port of ——, and bound for ——, the following articles of public property as specified below (contents and value unknown), in apparent good order and condition, to be forwarded to ——, the dangers of the seas only excepted, and there to be delivered in like good order and condition unto ——, for which I have signed a bill of lading in duplicate. Freight to be paid on the original bill of lading by ——, Quartermaster, U. S. Army, at ——, and at the rates named below, and to the order of ——.

————.

————

—— QUARTERMASTER'S OFFICE,

————, 18—.

I certify that I have shipped this day by the ——, the stores specified in this bill of lading, and that the weight is —— pounds, and the measurement —— cubic feet.

————.

—— *Quartermaster, U. S. Army.*

Marks.	Nos.	No. packages	Contents.	Weight	Meas-ure't.	Rate.
				Lbs.	*Cb.ft.*	

The bill of lading consists of two parts, the *original* and *duplicate*, each to be certified by the shipping officer and receipted by the carrier. The original is given to the carrier at the time of making the shipment, and upon delivery of the property in good order and condition is receipted by the consignee and returned to the carrier, with such further indorsement as may be necessary to insure settlement for the service. The duplicate is promptly transmitted by mail or otherwise to the officer to whom the stores are shipped, and upon delivery of the property is receipted by him in like manner as the original and retained, if he is the paying officer; if not, it is forwarded to the paying officer, to be used in settlement for the service. If the shipping officer is not the paying officer, he is notified by letter of the receipt of the stores, in good or bad order as the case may be, as per bill of lading.

BINARY THEORY.—This theory in chemistry takes cognizance of the mode of construction of salts. It assumes that all salts contain merely two substances, which either are both simple, or of which one is simple, and the other a compound playing the part of a simple body. The best and most familiar illustration of the binary theory is common salt or chloride of sodium (NaCl), which is constructed of the metal sodium (Na) and the non-metal chlorine (Cl), and is at a glance seen to be a *binary compound* (a compound of two). In like manner, fluor-spar, or the fluoride of calcium (CaF), consists of the metal calcium (Ca) and the non-metal fluorine (F); iodide of potassium (KI), largely employed in photography, of potassium (K) and iodine (I); and bromide of silver (AgBr), also useful in photography, of silver (Ag) and bromine (Br). Considerable difficulty is experienced in including all salts under the binary theory, but in many cases the apparent difficulty may be got over. Thus, saltpeter, or the nitrate of potash (KO,NO_5), according to the ordinary mode of representing its composition in symbols, naturally breaks up into potash (KO) and nitric acid (NO_5); but in this form it cannot be correctly included in the binary theory. If, however, the same elements be arranged differently, as when the nitrate of potash (KNO_6) is represented as containing the metal potassium (K) and the compound non-metal nitrationide (NO_6), the latter playing the part of chlorine or other simple substance, the apparent barrier to the introduction of such salts into the list of those comprehended under the binary theory to a great extent disappears. The following table will represent this more clearly:

	Symbols. Ordinary Way.	Binary Theory
Chloride of sodium....	Na,Cl	Na,Cl
Nitrate of potash......	KO,NO_5	K,NO_6
Sulphate of soda......	NaO,SO_3	Na,SO_4
Carbonate of lime.....	CaO,CO_2	Ca,CO_3

Much, however, remains to be cleared up, and in very many cases the binary theory does not answer the purpose of including all salts under one class.

BINOCULAR MICROSCOPE.—A microscope adapted to be used by both eyes at the same time. It has only one set of object-glasses, but the pencil of light, after passing these lenses, is divided, and the parts are sent to the eyes separately. The division is caused by a trapezoidal prism that is pushed laterally into the pencil of light, cutting off one half; the other half goes on directly to one eye. That part of the pencil which is obstructed enters the lower face of the prism normally and is not there changed; it meets the second face internally at such an angle as causes it to be wholly reflected and to pass back through the glass to the third face; here it is again totally reflected, and it passes thence out of the glass normally through the fourth face. The result at all these changes of direction is to give it a path, slightly oblique to that of the unchanged ray, that will carry it through an oblique tube to the second eye. The rays of light cross in the objective; hence, to obtain a stereoscopic effect—that is, to cause the object to stand forth as a solid, its three dimensions being properly appreciated—the light which comes from the left side of the object must enter the right eye, and *vice versa*. Should the light from the right side enter the right eye, a pseudoscopic effect follows; projections seem hollows, and hollows look like elevations. The binocular microscope has two eye-pieces. It is restful to the eyes, and with low powers gives information not to be had otherwise, showing the depth, as well as the length and breadth, of the thing observed. The binocular telescope has two tubes and two sets of lenses throughout. A pair of opera-glasses is a familiar example. See *Field-glass*.

BINOMIAL.—In algebra, a quantity consisting of two terms or parts—e.g., $a + b$ or $9 - 5$; a *trinomial* consists of three terms, as $a + b + c$, or $10 + 5 - 8$. The Binomial Theorem is that remarkable series of analytical formulæ by which any power of a binomial can be expressed and developed. Thus, the eighth or any other power of $a + b$ can be at once written down without going through the actual multiplication of $a + b$ by itself for the given number of times. The older mathematicians were acquainted with this theorem in the case of integral exponents, though the actual discoverer is unknown. Newton was the first to demonstrate its truth for all exponents—fractional and negative, as well as integral. It is one of the finest of his discoveries, and is engraved on his tomb. Among its many applications, it affords the means of finding any root of any number much more conveniently than by the usual method of extraction.

BIPENNIS.—A war-axe used by the Phrygians. It was double-edged, having the edges set back to back, and between them the long shaft or handle is produced until it ends in a point. Sometimes the axe had but one edge, while on the other side it had either a hook or a hammer.

BIPORUS.—With the ancients this word signified a double-prowed boat, so that it could change its course to the opposite direction without turning.

BIRAGO BRIDGE.—A trestle-bridge, of which the supports are, for a depth of water less than 12 feet, a peculiar kind of adjustable horse. For water deeper than this, pontons made in several pieces joined together, or any large flat-bottomed boats, may be used. It may be so laid as to form several passage-ways in the same bridge, by joining a larger number of the parts of pontons together, and placing several rows of the horses. The horse is formed of a movable cap sustained at each end by a single foot. The cap is of spruce or pine, 17 feet long, 8⅝ inches deep, 6½ inches wide in the middle, and 8½ inches wide at the ends for a distance of 3 feet. A mortise 3½ inches wide by 10½ inches long is cut in each head of the cap for the passage of the foot, the bottom of the mortise being inclined 22°. The floor of this bridge is composed of planks 10⅝ feet long by 11½ inches by 1½ inches, with a notch at each end ½ inch deep and 18½ inches long, to receive the balks at the side of the bridge.

BIRD'S-EYE VIEW.—A term applied generally to modes of perspective in which the eye is supposed to look down upon the objects from a considerable height. If the eye is considered as looking perpendicularly down while it sweeps over each point of the scene in succession, we have an exact ground-plan; no object covers another, horizontal angles and distances are exactly represented; while, on the other hand, no vertical angles or side-views appear. In sketching or drawing a locality for military or economical purposes, this kind of perspective is always used. The great difficulty is to represent at the same time the relative heights of mountains and steepness of acclivities. But the more usual kind of bird's-eye views differ from common perspective only in the horizontal line being placed considerably above the picture. In the sixteenth century the only kind of views known were of the nature of ground-plans, and the artists of the seventeenth century tried to combine this method with side-views.

BISCAIEN.—A name formerly given to a long-barreled musket, the range of which was greater than the ordinary musket. At present this appellation is given to a leaden ball about the size of an egg, which is used for canister or case-shot.

BISCAYAN FORGE.—A furnace in which malleable iron is obtained direct from the ore.

BISCUITS.—Small flat bread rendered dry and hard by baking, in order to their long preservation. They are divided into two classes—the *unfermented* and the *fermented*. *Unfermented* or *unleavened* biscuits, generally known as *common sea-biscuits* or *ship-bread*, are made of wheaten flower (retaining some of the bran), water, and common salt. The materials are kneaded together, either by manual labor—that is, by the hands and feet of the workmen—or by introducing the materials into a long trough or box, with a central shaft, to which a series of knives is attached, and which is made to revolve rapidly by machinery. The mass of dough so obtained is then kneaded and thinned out into a sheet the proper thickness of the biscuits, by being passed and repassed between heavy rollers. This sheet being placed below a roller with knife-edge shapes, is readily cut into hexagonal (six-sided) or round pieces of dough of the required size of the biscuits. The indentation of the slabs of dough, in the case of the hexagonal biscuits, is not complete, so that all the biscuits cut out of each slab remain slightly adhering together. These slabs of biscuits are then introduced into an oven for about fifteen minutes, and are placed in a warm room for two or three days to become thoroughly dry. The more modern oven is open at both ends, and the biscuits being placed in a framework are drawn by chains through the oven. So rapidly is this operation conducted that about 2000 lbs. weight of biscuits are passed through one of these ovens every day of ten hours. The extent to which biscuits are now consumed may be learned from the fact that several of the largest biscuit-manufactories each prepare and throw into market every week from 30,000 to 50,000 lbs. weight of biscuits of various kinds. One of the largest and most complete biscuit-manufactories in England is that of Carr at Carlisle, whose biscuits, sold in tin boxes, are well known. Another bakery of this kind is that of Harrison of Liverpool. See *Hard-tack* and *Meat-biscuit*.

BISET.—A member of the National Guard who performed his duty in civilian's dress, before the wearing of uniform on duty was made obligatory.

BISHOP'S MANTLE.—A Venetian mail cape, with which the Doges were armed; it was also worn in Germany during the fifteenth and sixteenth centuries, and over the cuirass in Italy during the fifteenth century.

BISTER—BISTRE.—A pigment of a warm brown color, prepared from the soot of wood, especially beech. It is used in water-colors after the manner of Indian ink.

BITUMEN.—A mineral substance, remarkable for its inflammability and its strong peculiar odor; generally, however, supposed to be of vegetable origin. The name, which was in use among the ancient Romans, is variously employed, sometimes to include a number of the substances called *mineral resins*, particularly the liquid mineral substances called *naphtha* and *petroleum* or mineral oil, and the solid ones called *mineral pitch*, *asphalt*, *mineral caoutchouc*, etc.; sometimes in a more restricted sense it is applied by mineralogists only to some of these, and by some mineralogists to the solid, by others to the liquid ones. All these substances are, however, closely allied to each other. Naphtha and petroleum consist essentially of carbon and hydrogen alone, 84 to 88 per cent being carbon; the others contain also a little oxygen, which is particularly the case in asphalt, the degree of their solidity appearing to depend upon the proportion of oxygen which they contain, which amounts in some specimens of asphalt to 10 per cent. Asphalt also contains a little nitrogen. Bituminous substances are generally found in connection with carboniferous rocks, in districts where there is, or evidently has been, volcanic agency. See the articles already referred to. Indeed, most kinds of coal contain bitumen, and a substance essentially the same is produced from all kinds of coal by distillation; and whether before existing actually formed in the coal, or produced at the time by the action of heat, bitumen may often be seen bubbling from pieces of coal after they have begun to burn on an ordinary fire. Some of the shales of the coal-measures are very bituminous, as is also a kind of marl-slate abundant in some parts of the Continent of Europe. One of the most interesting of the bituminous minerals is that called *mineral caoutchouc* or *elastic bitumen*, and for which the new name of *elaterite* has been devised, as if to support the dignity of its exaltation to the rank of a distinct mineral species. It is a very rare mineral, only three localities being known for it in the world—the Odin lead-mine in Derbyshire; a coal-mine at Montrelais, near Angers, in France; and a coal-mine near South Bury, in Massachusetts. It is elastic and flexible like caoutchouc, and may be used, like it, for effacing pencil-marks. It is easily cut with a knife. Its color is blackish, reddish, or yellowish brown; and its specific gravity is sometimes a little less and sometimes a little more than that of water. It has a strong bituminous odor, and burns with a sooty flame. See *Coal*.

BIVOUAC.—The encampment of soldiers in the open air, without tents, where every one remains dressed and with his weapons by him. Even during the Seven Years' War it was no uncommon thing for the whole army, when in the vicinity of the enemy, to pass the night in their ranks, each lying down in his place, in order to be ready to stand to their arms at a moment's notice. But the French revolutionary armies introduced the practice of dispensing with tents altogether, and regularly passing the night *en bivouac*. Hence in a great measure that rapidity in their motions which long made them uniformly successful. The practice was afterwards imitated by the other armies of Europe, though less by the English. Soldiers in bivouac light fires, and improvise, where it is possible, huts of straw, branches, etc. But this mode of encampment, though favorable to celerity of movement, is purchased at the expense of the soldiers' health, besides being destructive of discipline, by leading to plundering and destroying of houses, fruit-trees, etc., in the vicinity. Accordingly, the tent is again coming into use, and for permanent encampments regularly constructed wooden huts have been introduced. There are still, however, many cases where the bivouac is the only resource.

The bivouac is formed as follows: A regiment of Cavalry being in order of battle, in rear of the ground to be occupied, the Colonel breaks it by platoons to the right. The horses of each platoon are placed in a single row, and fastened as prescribed for camps; near the enemy, they remain saddled all night, with slackened girths. The arms are at first stacked in rear of each row of horses; the sabers, with the bridles hung on them, are placed against the stacks. The forage is placed on the right of each row of horses. Two stable-guards for each platoon watch the horses. A fire for each platoon is made near the color line, twenty paces to the left of the row of horses. A shelter is made for the men around the fire, if possible, and each man then stands his arms and bridle against the shelter. The fires and shelter for the officers are placed in rear of the line of those for the men. The interval between the squadrons must be without obstruction throughout the whole depth of the bivouac.

An Infantry regiment going into bivouac forms its line of battle and then breaks into companies, like when it goes into camp. The arms are then stacked, and the fires made. These fires are on the ground that would be occupied by the tents in camp, and are sufficient in number to allow one for every eight or ten men. If possible, shelters are constructed; these are easily built in a wooded country. If liable to surprise, the infantry should stand to arms at daybreak, and the cavalry mount, until the return of the reconnoitering parties.

The Artillery can have no fixed rule for its bivouacs, being obliged to suit itself to localities; but in no case should the fires be near the park. The following arrangement is generally observed: In a single platoon of a mounted battery, the pieces and caissons are parked at eight yards' interval; the horses are tied to the prolonges (twenty-four feet long) stretched between the hind-wheels of the pieces, the distance between the pieces and caissons being increased; the harness, etc., is placed on the carriages, and any implements which could be injured by the horses are removed. If there be no forage on the caissons, the prolonges may be stretched between the hind-wheels of these carriages, the spare wheels being taken off. The men bivouac at a convenient distance in rear of the caissons; the guard is on the flank; the cook-fire is near the guard-tent. In a single platoon of a *horse-battery*, the carriages are parked in one line with ten yards' interval; the prolonges are lengthened by lariats doubled or trebled. If platoons are liable to be often detached, a rope should be provided for the cannoneers' horses. A battery bivouacs in a similar manner; the battery-wagon and forge are in line with the pieces; the picket-rope is ordinarily used instead of the prolonges. When practicable, the picket-rope, or prolonges, should be stretched between trees, etc., so as not to run the risk of having the carriages gnawed by the horses. See *Camp*, *Field-service*, and *Winter Quarters*.

BLACK.—In Blazonry, under the name of sable, denotes constancy, wisdom, and prudence.

BLACK-BAND IRONSTONE.—An ore of iron found very extensively in Scotland and elsewhere. It occurs in the carboniferous system of geologists, in regular bands, layers, or strata, and generally associated with coal and limestone. It is mainly a carbonate of iron accompanied by much coaly matter. The following is the composition of several samples:

	A.	B.	C.	D.	E.	F.
Carbonate of iron*.....	51.58	50.40	40.62	29.14	53.38	63.80
Carbonate of lime......	3.76	3.12	1.68	1.52	1.41	1.64
Carbonate of magnesia.	0.11	0.09	0.06	0.04	0.03	0.05
Alumina.....	0.74	0.82	trace	trace	trace	trace
Silica..................	20.96	26.56	8.48	19.84	2.76	4.48
Coaly matter	22.64	18.64	49.16	49.46	42.39	30.03
Water and loss..... ...	0.21	0.37	.....	.....	.....	....
	100.00	100.00	100.00	100.00	100.00	100.00
* Metallic iron, per cent	25.20	25.79	19.61	14.06	25.77	30.80

The black-band ironstone is easily reduced. It does not, however, yield a first-class iron when smelted by itself, and is therefore generally mixed with a small quantity of hæmatite (red iron-ore), which communicates strength and hardness to the iron obtained. See *Iron*.

BLACK-BOOK.—An ancient book of English Admiralty Law, compiled in the reign of Edward III. It has always been deemed of the highest authority in matters concerning the Admiralty in England.

BLACK-COATS.—Mercenary troops employed in the religious wars in the sixteenth century. Their appointments were black throughout, and they were armed with swords and pistols. They desolated the countries in which they were employed, and overwhelmed the humbler classes of the populations with their cruelties and depredations.

BLACK FLAG.—A flag of a black color, displayed as a sign that no mercy will be shown the vanquished, or that no quarter will be given.

BLACK FLUX.—A material used to assist in the melting of various metallic substances. Black flux is prepared by heating in a covered crucible ordinary or crude cream of tartar, or the bitartrate of potash ($KO,HO,C_8H_4O_{10}$), when the tartaric acid ($C_8H_4O_{10}$) is decomposed and charred, forming carbonic acid (CO_2), which remains in combination with the potash (KO) as carbonate of potash (KO,CO_2), accompanied by much free carbon. This very intimate mixture of carbonate of potash and carbon, otherwise called black flux, is a fine black powder of great service in the fluxing of metallic ores, as of lead and the separation of the metal therefrom. The black flux is likewise employed as the raw material from which, on the application of heat in iron vessels, the metal potassium can be obtained.

BLACK HOLE.—An appellation familiarly given to a dungeon or dark cell in a prison, and which is associated in the public mind with a horrible catastrophe in the history of British India—namely, the cruel confinement of a party of English in an apartment called the "Black Hole of Calcutta," on the night of the 18th of June, 1756. The garrison of the fort connected with the English factory at Calcutta having been captured by the Nabob Suraja Dowlah, this barbarian caused the whole of the prisoners taken, 146 in number, to be confined in an apartment 20 feet square. This cell had only two small windows, and these were obstructed by a veranda. The crush of the unhappy sufferers was dreadful; and after a night of excruciating agony from pressure, heat, thirst, and want of air, there were in the morning only 23 survivors, the ghastliest forms ever seen on earth.

BLACKING.—The material employed for producing a black glazed shining surface on leather. The main ingredient in the various kinds of blacking is bone-black, which is mixed with an oil, some sugar, and a little sulphuric acid. The materials in Day & Martin's blacking are finely powdered bone-black ground with sperm-oil, raw sugar or molasses, a little vinegar, and some concentrated sulphuric acid (specific gravity 1.850). The substances are incorporated together one by one in the order in which they are stated, and the action of the sulphuric acid is to convert much of the lime in the bone-black into sulphate of lime, which causes a thickening of the mixture, and a tenacious paste results. This paste, diluted with weak vinegar, is put, while warm, in stone-ware bottles, and is then ready for the market.

Blacking for shoes, belts, etc., consists of three parts of white wax, seven and a half parts essence of turpentine; one and a half parts of ivory-black. The wax is cut into small pieces and put into a glazed vessel. Spread the turpentine over it, and leave it for twenty-four hours. Then mix it by degrees with ivory-black. To use it, spread it with a rag in a thin layer on the leather, and afterwards rub with a soft brush.

Blacking for harness consists of yellow wax, four parts in weight, six parts essence of turpentine, one part of mutton-suet, and one part of ivory-black. Cut the wax into small pieces, and leave it to soak twenty-four hours in the essence of turpentine; grind in separately the ivory-black and suet until there is a perfect mixture of the whole mass. When the leather has lost its color, it may be restored by the mud of ink, or by sulphate of iron in a thick solution, spread upon the edges.

BLACKWALL HITCH.—A bend to the back of a tackle-hook or to a rope, made by passing the bight round the object and jamming it by its own standing part. See *Cordage*.

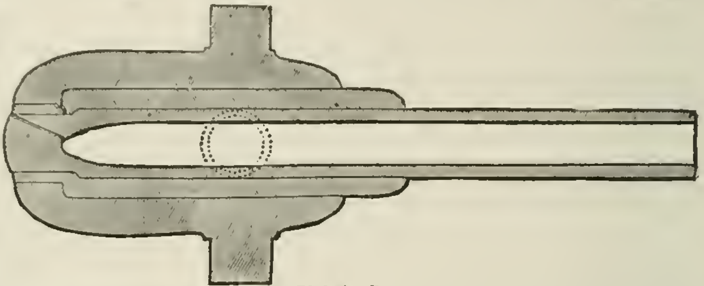
BLACK WATCH.—The appellation given to certain armed companies employed to watch the Highlands of Scotland. The term *black* arose from the dress of this species of militia, which was composed of tartans of dark colors. Some Highlanders had been armed by Government as early as 1725, when General Wade was appointed Commander-in-Chief in Scotland; but it was not till about 1729 or 1730 that the companies assumed a regular form. The companies were six in number—three comprising 100 men each, commanded by a Captain; and three of 70 men each, commanded by Lieutenants, acting as Captains. Stationed in different parts of the Highlands, and acting independently of each other, they were styled the Independent Companies of the Black Watch. The body was raised chiefly from the Whig or loyal clans—Campbells, Grants, Munros, etc.—and many men of good station in society joined it, not only for the sake of good pay, but for the valued privilege of bearing arms. The duties of the Black Watch were to enforce the Disarming Act, to overawe the disaffected, to prevent political meetings of a seditious kind, and to check depredations among the clans, or on the Lowland frontier. After being of considerable use for these local purposes, the whole of the companies were formed into the 42d Regiment, under the command of the Earl of Crawford, in 1739—their removal giving facility, no doubt, for the outbreak of the Rebellion in 1745. Retaining its original Highland character, the 42d Regiment became one of the most distinguished Corps in the British army; the whole of its history, for which we would refer to the work of Colonel Stewart on Highland Regiments, being a series of brilliant achievements. Embodied under the Earl of Crawford, the regiment would have adopted the tartan of that nobleman, if he had possessed such a cognizance; the Earl, however, being a Lowlander, it was necessary to adopt an arbitrary pattern of tartan, which has ever since been known as the 42d or Black Watch tartan.

BLACKWOOD.—A tree growing in Southern India in the Annamallay Forest, and in other parts of India and Burmah. The wood is close-grained, strong, flexible, fibrous, durable, and of a very deep purple color. It is used in the Bombay Gun-carriage Agency for beams, cheeks, axle-beds, and poles of field-carriages.

BLAISE.—A military order instituted by the Kings of Armenia, in honor of St. Blaise the Martyr, anciently Bishop of Sebasta, and the Patron Saint of Armenia. Justinian calls them Knights of St. Blaise and St. Mary, and places them not only in Armenia, but in Palestine.

BLAKELY GAS CHECK.—This consists of a taper breech-screw, devised to realize the advantages of a plug parallel with the bore, and yet to withdraw the plug without unscrewing its whole length. After the plug is unscrewed two or three turns, it may be withdrawn longitudinally, on a prepared slide, without further turning. The thin end of the screw forms a kind of gas-check.

BLAKELY GUN.—The most approved pattern of the Blakely gun combines in its construction the principles of "initial tension" and "varying elasticity," the object of which is to bring the strength of all the metal of the piece into simultaneous play, to resist explosion. The drawing shows the general features of the gun. The inner tube, or barrel, is made of low steel, having considerable but not quite enough elasticity. The next tube is made of high steel with less elasticity, and is shrunk on to the barrel with just sufficient tension to compensate for the insufficient difference of elasticity between the two tubes. The outer cast-iron jacket, to which the trunnions are attached, is the least elastic of all, and is put on with only the shrinkage attained by warming it over a fire. The steel tubes are cast hollow and hammered over steel mandrels, under steam-hammers: by this process they are elongated about 130 per cent; at the same time the tenacity of the metal is increased. All the steel parts are annealed.



Blakely Gun.

Captain Blakely uses other combinations of these metals, the simplest of which is a cast-iron gun with hoops of steel surrounding the reinforce. He objects to the use of wrought-iron on account of its tendency to stretch permanently. Blakely guns are rifled with one-sided grooves, and are fired with expanding projectiles. The following are the dimensions, etc., of Blakely all-steel guns:

Guns.	Weight.	Diam. of Bore.	Length of Bore.	No. of Grooves.	Twist.	Weight of Projectile.	Weight of Powder.
	Lbs	In.	In.		1 turn in Calibers.	Lbs.	Lbs.
100-pdr....	8,000	6.4	96	8	48	100	10
120-pdr....	9,000	7	100	8	48	120	12
200-pdr....	17,000	8	44-156	12	48	200	20
250-pdr....	24,000	9	do.	12	48	250	25
350-pdr....	30,000	10	do.	15	48	350	35
350-pdr...	35,000	11	do.	12	36	550	55
700-pdr....	40,000	12	do.	12	36	700	70

See *Ordnance*.

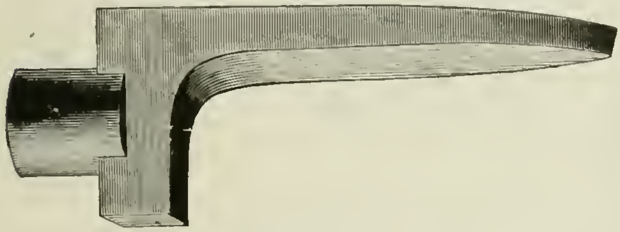
BLAKELY PROJECTILE.—This projectile has an expanding copper cup attached to its base by means of a single tap-bolt in the center, or other simple means. It is prevented from turning by radial grooves cast on the surface of the bottom of the projectile, into which the cup is pressed by the charge. The angle between the curved sides of the cup and the bottom of the projectile is filled with a lubricating material. On the forward part of the body are soft metal studs, more numerous than the grooves of the bore of the piece, that some of them may always form a bearing surface for the projectile against the lands. The driving sides of the grooves are deeper than the other. See *Expanding Projectiles.*

BLANCHARD LATHE.—A lathe for turning irregular forms, invented by Mr. Thomas Blanchard. It was the first successful lathe for turning gun-stocks, axe-handles, etc. The idea was partly elicited in Brunel's block-turning machine. The art of turning is most applicable in all the mechanical arts; for the hardest metals, and the most ponderous articles, as well as the softest wood and the most delicate pivots. See *Lathe.*

BLANCHARD PONTONS.—Tin cylinders terminated by hemispheres, 19½ feet in length, 2¾ feet in diameter, weighing 565 pounds, and with a buoyancy of 7110 pounds. They are divided into nine water-tight compartments, each provided with a screw-plug for the insertion of a sucker-pump. When placed at open order, 12½ feet apart, they bear infantry, cavalry in sections, or light field-artillery; when placed 8 feet apart they will bear siege-artillery. The heaviest guns may be towed on a raft of three or more pontons. The bridge formed with these pontons can be boomed out from the shore at the rate of five minutes per ponton.

BLANCH-LYON.—A title of one of the English pursuivants-at-arms. See *Pursuivant.*

BLANK.—1. A piece of metal brought to the required shape and ready for the finishing operation, whatever it may be. A planchet of metal, weighed, tested, and milled, is a *blank* ready for the die-press, which converts it into a coin. A strip of softened steel made into the required shape is a *blank*, which cutting and tempering transform into a *file.* A



Rifle Breech-pin Blank.

piece of iron with a flaring head, and otherwise properly shaped ready for nicking and threading, is a screw-blank, which with the final operations becomes a screw. The drawing shows the *blank* from which is made the rifle breech-pin.—2. The point of a target at which aim is taken, marked with a white spot; hence the object to which anything is directed.

BLANK CARTRIDGE.—The blank cartridge consists of a copper case, 70 grains of musket-powder, a cup-anvil, ½ grain percussion-powder, and a patch of black wax. The copper for blank cartridges is rolled in strips 35 inches long, 3.2 inches wide, and .024 of an inch thick; each strip will cut forty-two disks. The process of manufacture of the cases, etc., is the same as for the ball-cartridges up to the point of loading. This is done by boys, by hand, the case being loaded by a charger, and closed by pressing a

piece of soft black wax upon the open end. The cartridges are then wiped clean and the waxed end touched with shellac varnish. They are afterward put up in suitable paper boxes, which are packed in wooden boxes for transportation. The black wax, which is entirely dissipated by firing, is made by boiling for two hours 15 lbs. beeswax and 1 lb. rosin in one gallon of pine-tar. The following materials are required for 100,000 blank cartridges: 2390 lbs. sheet-copper, scrap one third, .03 inch thick; 575 lbs. sheet-copper, scrap one third, .045 inch thick; 1145 lbs. musket-powder (80 grains to each cartridge); 7¼ lbs. percussion-powder; 32 lbs. nails, 8d.; 4 lbs. nails, wrought; 15 lbs. paint; 1 pound twine; 1028 lbs. tarred boards, scrap 10 per cent; 1 quart varnish; 800 feet lumber; 4¼ gross screws; 25 lbs. paste; 1¼ lbs. putty; 45 lbs. paper covers; 3 lbs. glue. See *Center-fire Metallic-case Cartridge.*

BLANKET.—A course, heavy, open, woolen fabric, adapted for bed-covering, and usually napped. It may be twilled or otherwise. The name is applied to any coarse woolen robe used as a wrapping. The *poncho* is a blanket with a hole in the center for the head to go through. It is worn by the South Americans, Mexicans, and Pueblo Indians.

BLANKET-BAG EQUIPMENTS.—The blanket-bag now supplied by the United States Ordnance Department is a substitute for the clothing-bag formerly issued, and is designed to be worn without the "carrying-brace." Two "clothing-bag straps" are supplied in lieu of the brace system, each 23 inches long, 2 inches wide at one end, and 1½ inches wide at the other. On the wide end is sewed a standing leather loop, open, on the undressed side of the strap, and having a small brass-wire loop, to receive the coat-strap, on the blackened side, attached by a chape sewed and riveted under the leather loop. A double brass-wire hook is attached to the small end of the strap, which is passed through its eye (the back of the hook toward the undressed side) and secured by another hook riveted on and passing through holes punched in the strap to regulate the length. A sliding loop slipped over the fold in the strap keeps the double-wire hook in place. The straps are attached to the bag by means of two rectangular brass-wire loops at the top. To attach the strap, remove the double-wire hook and the sliding leather loop; pass the strap through the rectangular brass loop at the top of the bag from the back of the bag toward the side of the flap, holding the blackened side of the strap toward the bag and observing that the straps are "rights" and "lefts." The straight edges of the straps should be toward the middle of the bag. Next, pass the small end of the strap through the standing leather loop at the wide end and draw the noose thus formed up close to the rectangular wire loop on the bag. The small brass loop on the strap should be drawn through the brass loop on the bag so as to remain on the outside. Next, put on the sliding leather loop and then the double-wire hook. Adjust the strap to the desired length by means of the hook at the end, and pass the sliding loop over the fold in the strap. To attach the coat-strap, slip the sliding loop down to the buckle and pass the billet end through the small brass loop on the blanket-bag strap, holding the blackened side of the coat-strap toward the bag; pull the strap through to within one foot of the buckle; pass the billet through the sliding leather loop and push the latter down close to the brass loop through which the strap passes. The coat-strap should be inserted in same direction with regard to the bag as the blanket-bag straps—that is, so that when the strap hangs double over the flap of the bag the buckle end will be outside. To sling the bag, first hook the left-hand strap to the D ring on the lower left-hand corner of the bag, pass the left arm through this strap, grasp the end of the other strap with the right hand, swing the bag over the shoulders, carrying the right-hand strap over the head; bring this strap down over the right shoulder and hook it into the D ring at the lower right-hand corner of the bag. The webbing loop with button and button-hole at the bottom of the blanket-bag is designed to carry the tin cup. When the bag is filled, the flap is fastened down by passing the leather loops at the corners over he buttons on the gussets. A haversack-strap is also made of leather and supplied with double-wire hooks at each end like those on the blanket-bag straps. These hooks are inserted into the buckles at the top of the haversack. No change has been made in the haversack except to enlarge the pocket for the meat-

ration can. It can be used with either the carrying-brace or the haversack-strap now provided. A leather strap similar to the haversack-strap (only narrower) is now provided for the canteen. Iron-wire loops are attached to the sides of the canteen to receive the double-wire hooks on the strap.

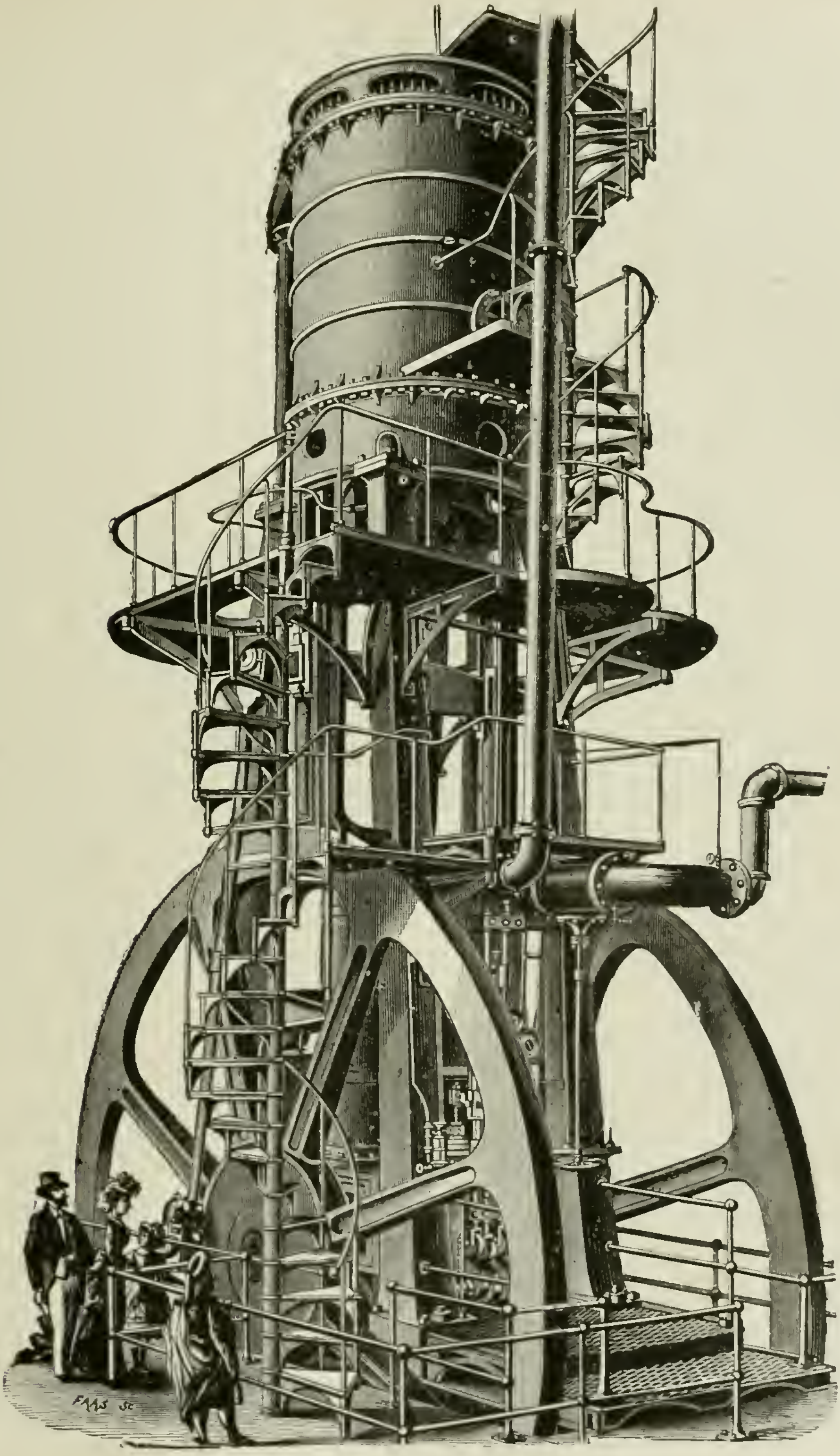
BLANKET-BOATS.—A practical and highly useful plan for crossing streams is by means of boats constructed of a single rubber blanket, capable of carrying a soldier, knapsack, arms, and accouterments, with only 4 inches of flotation. The size of some of the ordinary blankets is 6 feet long and 4¾ feet wide; but 7 feet by 5 feet would be preferable. If the height of the boat be made 1 foot, the length will be 4 feet and the width 2¾ feet, so as to be completely covered by the blanket. The frame may be made of round sticks, 1 inch and 1½ inch in diameter. In using these boats it will be convenient to lash several together, side by side, upon which soldiers can be transported. The frames are abandoned or used for fuel when the army has crossed over. See *Canvas-boats*.

BLANKETEERS.—A number of operators who, in 1817, met in St. Peter's Field, near Manchester, England, many of them having blankets, rugs, or great-coats rolled up and fastened to their backs. This was termed the "Blanket Meeting." They proceeded to march towards London, but were dispersed by the Magistracy. It is stated that their object was to commence a general insurrection. Eventually the ring-leaders had an interview with the Cabinet, and a better understanding between the working classes and the Government ensued.

BLAST.—The long flash from the muzzle of a piece of ordnance, and the rapid rush of the suddenly produced powder-gas, cause a very powerful *blast*, which acts destructively on objects close at hand lying in its path. In siege-batteries the parapets become damaged from the effects of their own fire. When the *blast* is confined in a narrow embrasure (temporary work the sides soon crumble away after repeated firing, entailing constant repair. Not only, however, is the embrasure gradually destroyed, but frequently the revetment of its sides catches fire or smoulders, rendering great care necessary in taking out fresh cartridges in loading.

BLAST-ENGINE.—For smelting and refining furnaces, where a blast with a pressure of some pounds per square inch is required, blowing-engines of large size are usually employed. Such an engine consists of a steam-engine, with the ordinary steam-cylinder at one end and a blast-cylinder at the other end of the beam. Such, at least, is the construction preferred for the larger-sized engines; but sometimes a horizontal arrangement of the cylinders is adopted for those of smaller size. The blowing-cylinder is of cast-iron, with an air-tight piston, which, as it ascends and descends with the motion of the engine, alternately inhales and expels the air at each end. A blast-engine at Shelton Iron-works, of which the blowing-cylinder is 8 feet 4 inches in diameter, and has a 9-foot stroke, working with 186 horse-power, and making 32 single strokes of the piston per minute, inhales 15,700 cubic feet of atmospheric air per minute; but this is compressed by the blowing-cylinder to a pressure of 3 lbs. per square inch above the atmosphere, which reduces the volume supplied by the cylinder to 13,083 cubic feet. Its volume, however, is largely increased again, when raised to the hot-blast temperature, before entering the furnace. In the Catalan forges of Spain and the south of France there is a very ingenious water-blowing machine in use, called a *trompe;* but it can only be advantageously employed where a fall of a few yards of water is available. The height from which the water falls determines the tension of the blast; but the height seldom exceeds 27 feet, which gives a pressure of from 1½ to 2 lbs. to the square inch. It is asserted that no other blowing-machine gives so equable a blast as the trompe, and it is the least costly of any; but it has the serious defect of supplying air more or less saturated with moisture. The theory of this singular machine has never been satisfactorily explained, although one or two able philosophers, who have specially studied the matter, incline to the belief that much of the air is carried down the pipe by becoming entangled in water. It is found that the separation of the air from the water is greatly promoted by allowing the falling current to impinge on a narrow platform, about midway of the wind-chest.

The engraving on the opposite page represents the blast-engine exhibited at the U. S. International Exhibition, in 1876, by the I. P. Morris Company, and which is constructed after a style now much in favor with many American furnace-managers. In its design the following points were sought to be obtained: compactness, without sacrifice of accessibility to moving parts; self-adjustment of parts liable to inequalities of wear; steadiness of the whole structure, and preservation of alignment by being self-contained. All the parts are proportioned to the work of supplying blast of 10 lbs. pressure steadily, if needed; and though the ordinary working of anthracite-coal-burning furnaces does not demand that high pressure, it has been exceeded in one case, 13½ lbs. having been blown off for a considerable period of time without damage to the engine. The Wanich equilibrium valve with which this engine is fitted was applied first about eight years ago to an engine at the Lebanon Furnaces, and soon after it was applied to a second engine at the same furnaces, on both of which it has proved highly satisfactory, saving steam and being entirely manageable. Double-beat valves will leak even if ground in, under steam, owing to unequal expansion between themselves and the chamber containing their seats. The single-beat valve with a "pilot" or supplementary valve is not easily handled on blast-engines, where it is found best, in order to promote regularity of motion, to set the steam-valves late, sometimes so much that the piston has moved one twelfth of its stroke before steam is admitted; consequently the passage,



Blast-engine.—I. P. Morris Company.

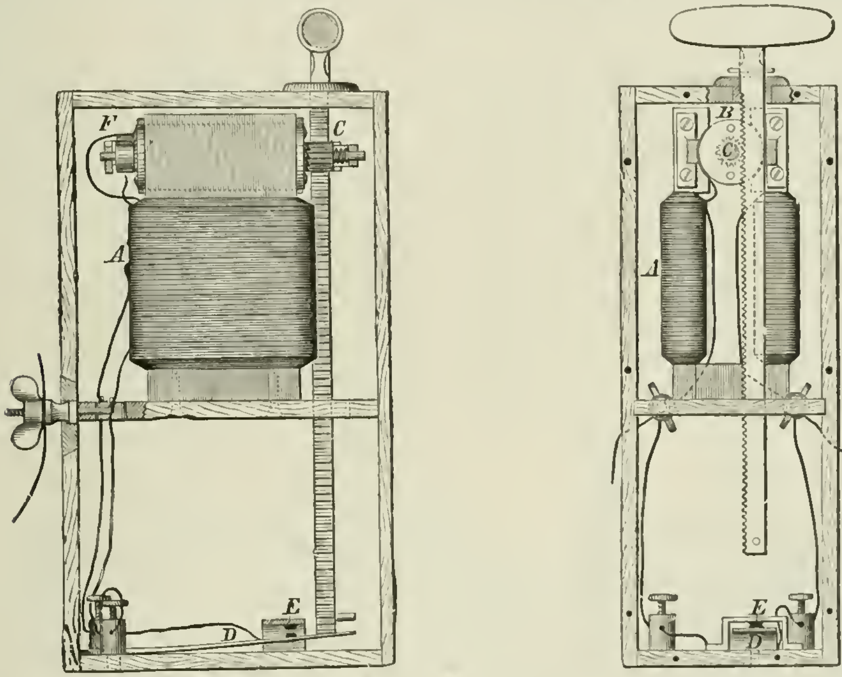
and space within the cylinder to be filled are proportionately so great and rapidly increasing that steam cannot pass by the pilot-valve fast enough to equalize the pressure on the upper and under sides of the main valve unless the pilot-valve be increased largely in area, when it becomes unmanageable by hand. To overcome this, Mr. Wanich, foreman of the machine-shop of the I. P. Morris Company, designed the valve illustrated, and found its action to realize what was anticipated of it. It consists in the use of a ring cast on the back of the main valve, extending upward, and bored out so as to envelop and slide freely upon the outside of another ring cast on the steam-chest bonnet, dropping downward and turned off. The rings are, of course, concentric, and the annular space between them is quite small in area, very much less than the aggregate area of the holes for the passage of steam below the pilot-valve; consequently any steam passing the annular opening when the pilot is raised goes freely through into the cylinder, exerting no appreciable pressure on the back of the main valve, and permitting it to rise easily. This absence of pressure has been proved by connecting with the space inclosed by the rings an ordinary steam-gauge, which showed the pressure when the pilot was seated to be, say, 35 lbs., and when the pilot was raised the pressure suddenly fell to almost zero until the main valve opened, when it rose again to 35 lbs. The blast-valves are of selected thick sole-leather backed with plate-iron; blast-piston fitted for either metal, wood, or bag packing; steam-piston fitted with metal double rings held out by springs; valves are lifted by cams operating directly against rollers fitted into the bottom ends of the lifting-rods. The cams are adjustable, but not variable, and give facilities for experimenting to determine the best distribution of steam without interference with each other. The cam-shaft is driven by spur-gears fitted to the main shaft. The fly-wheels are large, and weigh nearly 18 tons. The rim on the side in line with the crank-pin is cored out so that the preponderance of the opposite sides will counterbalance weight of pistons, rods, cross-heads, etc. The shafts are of wrought-iron with ample bearing-surface. The cross-head swivels in the yoke connecting the two piston-rods, and is provided with spherical journals for the connecting-rods, so that it may accommodate itself to any inequalities of wear in the main shaft or crank-pins. The height of the engine compared with its base is suggestive of instability, but that defect does not exist. A foundation of hard bricks or good stone, long and wide enough to take the bed-plate, and 10 feet deep, is known to be quite sufficient to sustain the engine without perceptible swaying of the top. This height is mainly due to length of stroke compared with diameter of blast-cylinder, whereby a given quantity of air can be supplied by a lesser number of revolutions —usually in engines of this stroke not exceeding twenty—and with fewer beats of the blast-valves; and as with fixed diameter of blast-cylinder the loss in delivery due to piston-clearance and space in the passages is a certain quantity, it is clear that the percentage of loss of useful effect from this cause diminishes as the stroke increases. The dimensions of the principal portions of the engine are as follows: blowing-cylinder, 90 inches diameter, 7 feet stroke; steam-cylinder, 50 inches diameter, 7 feet stroke; two fly-wheels, each 24 feet diameter; bed-plate, 13 feet by 8 feet; total height of engine, 36¼ feet; capacity, 10,000 cubic feet of air per minute.. See *Blower* and *Iron*.

BLASTING.—Before gunpowder was invented, the separation of masses of stone from their native rock could only be effected by means of the hammer and wedge, or by the still slower method of fire and water. In soft and stratified rock, wedges are still used for quarrying stones for building purposes, but in hard rock, or where regularity of fracture is no object, gunpowder is universally employed. Blasting is either accomplished by the *small-shot* system, or by large blasts or *mines*. Small shots may be fired, even under water, by inclosing the charge in a tin case, with a tube of powder reaching to the surface; or in a canvas bag, well tarred, and tied at the neck round a length of Bickford's fuse, which burns under water. The charge is inserted in the drill-hole, and the weight of the superincumbent water acts as tamping. In removing the wall between the old and new Shadwell basins of the London docks, shots were fired under water within a few yards of vessels lying in the basin, by using moderate charges, and by keeping a raft of timber floating over the hole, as a shield to prevent anything flying upwards. The Voltaic battery has been used for firing shots, chiefly under water, since 1839, in which year it was employed at the wreck of the Royal George and at the Skerryvore light-house.

When a large mass of rock has to be removed at once, recourse must be had to large blasts or *mines*. The greatest isolated example of this kind of blasting was the overthrow, in 1843, of the Rounddown cliff at Dover, by 18,500 pounds of powder, in three separate charges, fired simultaneously by voltaic electricity. These large blasts are of two kinds: either *shafts* sunk from the top of the rock, or *headings* driven in from the face. The shaft-holes are 6 feet long by 4 feet wide, of various depths, according to the height of the rock, but seldom much exceeding 60 feet. The deal-box, with the charge of powder, is placed in a chamber cut at one side of the shaft, so that the tamping may not be in the direct upward line of fire. The tamping consists of the stone and débris which have come out of the shaft; and the wires from the battery are protected from injury by being laid in a groove cut in a batten placed up one angle of the shaft. It is evident that the same point in the rock may be reached as well by a heading or gallery driven in from the face of the rock as by a shaft from the top, and often by a shorter route. Headings are made 5 feet high by 3 feet 6 inches wide, and are driven, if possible, along a natural joint in the rock. The direction of the gallery is changed and sunk at parts, to prevent the tamping from being blown out. Four men can, on the average, drive 5 feet run of heading per week; but cannot sink above 3 or 4 feet of shaft, which has a greater sectional area, and is more inconvenient to work in. The charge of powder may be divided and placed in two or more separate chambers, and it is better thus to spread a heavy charge over a length of face than to have it in one spot, at a greater distance from the face than about 30 feet. The charges for these mines vary from 600 to 13,000, and even more, pounds of powder; and the produce is from 2 to 6 tons of stone to the pound of powder, according to the density of the rock and the position of the mine. In military blasting, or where total destruction is aimed at, an excess of powder is little or no objection. Of late years great improvements have been effected in the production and application of explosive agents other than gunpowder, which latter, until lately, may be said to have been exclusively used for the purpose of blasting. Nitro-glycerine and gun-cotton were discovered within two years of each other; but while gun-cotton was immediately applied to industrial purposes, nitro-glycerine was destined to remain a chemical curiosity for about 16 years. Dynamite is a preparation of nitro-glycerine and porous earth, in the form of a pasty mass, which, without materially impairing its explosive properties, has the effect of rendering it perfectly safe to handle.

A great variety of electric blasting apparatus has been devised and tested in the last few years; but a remarkably simple and effective magneto machine made by the Laflin and Rand Powder Company possesses more points of merit than any other single machine made. It is constructed on the Wheatstone and Siemens principle, having a magnet of the horseshoe character, of iron, wound about with coils of insulated copper wire; between the poles of the magnet there is fitted to revolve an armature of cylindrical construction carrying in its body other insulated wire coiled longitudinally, as to the cylinder. The rapid revolution of the armature, by suitable means, generates and sustains in the machine an accumulative current of voltaic electricity of great power, which at the moment of its maximum intensity is, practically, switched off to the outside circuit in which are the fuses, and in the interior of each fuse the ignition is accomplished instantly. The drawings show the interior arrangement of the machine: *A*, the principal magnet; *B*, the armature revolving between the poles of the principal magnet; *C*, the loose pinion, its teeth engaging with the rack-bar, and by clutching also engaging with the spindle of the armature on the downward stroke (only) of the rack-bar; *D*, the spring which, when struck by the foot of the descending rack-bar, breaks the contact between two small platinum bearings, and this causes the whole current of electricity to pass through the outside circuit,—the leading wire and fuses; *E*, the two platinum bearings, one on the upper face of the spring, the other on the under side of the yoke over the spring; *F*, the commutator.

Platinum-fuses are specially made for this machine, and the manner of using is very simple. A fuse should be used with the wires attached, of such length that the ends may protrude from the surface after the hole is charged, the fuse-head being in the center of the charge. Tamp with dry sand, or in such a manner that the wires may not be cut or the insulated covering upon them be injured. When all the holes to be fired at one time are tamped, separate the ends of the two wires in each hole, joining one wire of the first hole with one of the second, the other or free wire of the second with one of the third, so proceeding to the end or last hole. If the wires attached to the fuses should not be long enough, use connecting wire for joining. All connections of wires should be by hooking and twisting together the bare and *clean* ends, and it will be best if the parts joining be bright. The charges having all been connected as directed above, the free wire of the first hole should be joined to one of the "leading" wires, and the free wire of the last hole with the other of the two leading wires. The leading wires should be long enough to reach a point at a safe distance from the blast—say two hundred and fifty feet at least. All being ready, and not until the men are at a safe distance, connect the leading wires, one to each of the projecting screws on the front side of the machine, through each of which a hole is bored for the purpose, and bring the nuts down firmly upon the wires. Now, to fire, taking hold of the handle for the purpose, lift the rack (or square rod toothed upon one side) to its full length and press it down, for the first inch of its stroke with moderate speed, but finishing the stroke with all force, bringing the rack to the bottom of the box with a solid *thud*, and the blast will be made. Platinum-fuses are not in any case to be fired by a spark or by the effects of free electricity, needing a current of sufficient strength and persistence that in its passage through the circuit it shall heat to redness a small bridge of fine platinum wire in the body of the fuse.



Magneto Machine.

The most extensive operation of blasting ever witnessed in the United States was, perhaps, the removal of the reefs in the East River, at Hallett's Point, near New York, known as the "Hell Gate Improvement." The rock to be removed extended more than 100 yards into the river, greatly narrowing the channel and rendering navigation extremely difficult. The plan of operation was to sink a large square shaft on the Long Island shore from which the rock projected, and to run into the rock at a proper depth long galleries radiating from the place of entrance like the lines of an expanded fan. The entrance-shaft was nearly 100 feet square, and its bottom was 32 feet below low water. Nearly 20 tunnels were bored in all directions, extending from 200 to 240 feet, and all were connected by lateral galleries. All the excavated rock was hauled to the entrance and hoisted to the surface. The work was completed in September, 1876, and made ready for blasting with more than 52,000 pounds of explosive material in many thousands of holes drilled for the purpose. The explosives were dynamite, rendrock, and vulcan powder. On the given day a quarter of a million people found their way to points on land and water where the explosion could be seen. When the eventful moment arrived, General Newton, the Engineer in charge, took the hand of his little girl, a mere infant, and with it pressed down the key by which the battery was fired. There was a rumbling or shaking of the ground, the rising of a great mass of water from 20 to 40 feet in the air, a few small stones thrown a little higher, an immense mass of smoke, and all was over. Millions of tons of rock had been shattered, and yet the noise and the shock were less than would have attended the simultaneous discharge of half a dozen field-pieces in the open air. There was so much doubt and ignorance about the possible effect of this explosion that many people living one, two, and three miles away left their houses and took positions in the open air, through fear of wide-spread ruin. The work was completed successfully, and after dredging out the broken stone the navigation of the channel was greatly improved. In previous years much has been done in the harbor of New York by surface-blasting, i.e., lowering to the face or to some crevice of a rock cans filled with nitro-glycerine and exploding it by electricity, the effect being to gradually wear away the rock. The great work of the Sutro Tunnel was another triumph for American engineering. See *Mines*.

BLASTING-FUSE.—The common *blasting-fuse* is merely a tube filled with a composition which will burn a sufficient length of time to allow the person firing it to reach a place of safety before it is burnt out. The safety-fuse, by which the charge can be fired by a man at a considerable distance, is also much employed. Some of these consist of a tape of soft material saturated with a highly inflammable compound (fulminates are employed in some to increase the speed of the flame), and covered with an envelope of water-proof material. Firing by electro-battery is much safer. See *Fuse* and *Platinum-fuse*.

BLASTING-POWDER.—An explosive, in the form of powder, used for blasting. The most powerful blasting-powders in common use are made by adding certain substances to nitro-glycerine which, by absorbing it, reduce it to the form of powder, and thus render it comparatively safe against the shocks and jars of use. The term *blasting-powder* is also specially applied to a powder analogous to gunpowder, but which contains sodium nitrate in place of potassium nitrate, or saltpeter.

There are two grades of *blasting-powder*, branded "A" and "B." "A," the best grade in quality, is packed in wood or metal kegs of twenty-five pounds each, and is branded as to size, "CC," "C," "F," "FF," "FFF," "FFFF," "FFFFF," "FFFFFF," and "glazed" or "unglazed" as may be desired. "CC" is the coarsest size, the others being finer, in the order as given above. "B," of which the greater

"CC" Blasting-powder.

quantity is sold, it being best adapted to most work, is packed in the same manner as the "A" The sizes are from "C," coarsest, to "FFFF," finest, "glazed" or "unglazed." "B" *blasting-powder* was first successfully made at one of the mills of the Laflin & Rand Powder Company, and to that success the country is indebted for a cheaper grade of powder than had ever been known before, and one as well adapted to most of the rock-excavation to be done as the higher grade, while for military mining it is entirely superior. It is a slower-burning powder than the "A," but produces a greater volume of expansive gases, and in soft rock lifts a large mass, rather than shatters to small fragments a less quantity.

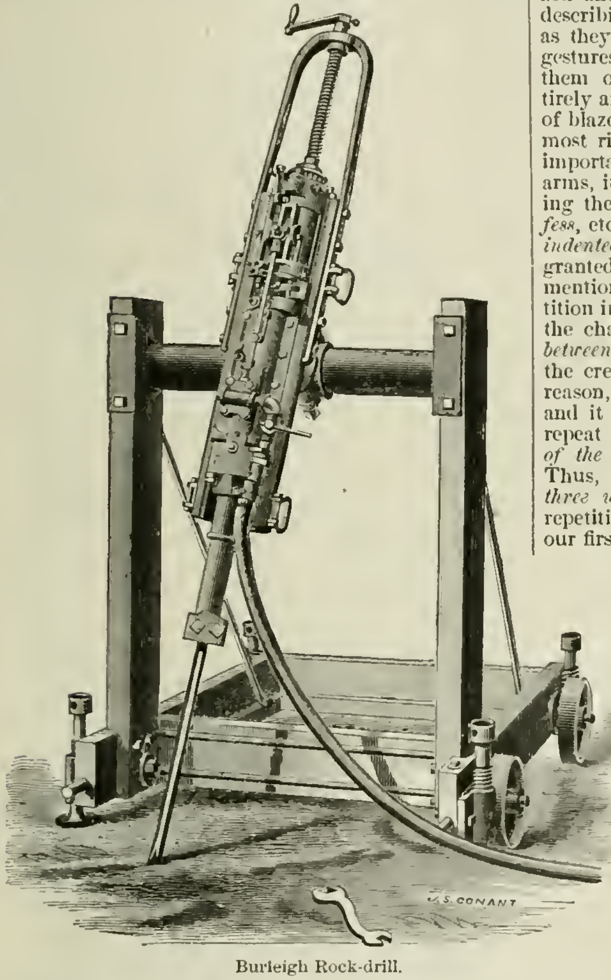
The drawing fairly shows the size of "CC" blasting-powder, either "A" or "B." See *Gunpowder* and *Mines*.

BLAST-METER.—An anemometer applied to the nozzle of a blast-engine. The Colliau meter is at present used by most furnace-managers. The following are the directions for its use:

1st. Place the meter in vertical position and as close as possible to the blast-gate, connect it with air-box by means of a half-inch gas-pipe and a short piece of India-rubber pipe between gas-pipe and meter. 2d. Pour into the meter about one half-pint of water. The water will stand at the same height in both tubes, at about mark 4. 3d. When the blast is put on, the water will descend on one side of the gauge; then loosen the screws of the sliding gauge so that it moves easily and slide the gauge downward until the 0 mark of the gauge reaches the level of the water of the descending side. Fix the gauge there by means of the lower screw. 4th. The mark on the gauge corresponding with the level of water in the ascending side will then represent the pressure in ounces per square inch. 5th. The amount of water put in is sufficient for a pressure of 7 to 8 ozs. Should a greater pressure be required, pour in a little more water. 6th. When the water on the lower side descends below the zero, slide down the gauge so that the zero of the gauge is level with the water. 7th. In cold weather it would be better to use spirits instead of water. To let the liquid out, open the small valve at the bottom. 8th. This blast-meter is calculated for sea-level. When the altitude is much greater a special gauge is required. See *Foundry*.

BLASTS.—Small chambers or holes made in rock or masonry, and charged with powder. The forming of blast-holes requires the use of particular tools, called *borers, jumpers, scrapers, needles*, and *tamping-bars*. To form the blast-hole, two or three men are required. One holds the borer with both hands, while the head of it is struck with sledge-hammers by one or two others. The first turns the borer at each stroke so that the hole may be circular, and from time to time clears it out with the scraper. When the hole required does not exceed 15 inches in depth, it may be excavated in the above manner; but if 20 inches, or more, deep, the jumper is generally made use of. The miner holds the jumper in both hands, raises it, and lets it fall in the hole, turning it continually; he also clears the hole with the scraper. When the stone is of a very hard description, it is usual to pour water occasionally into the jumper-hole.

Blast-holes are seldom made by hand nowadays, when the use of the rock-drill is possible. The drawing shows the Burleigh rock-drill mounted on a frame for surface and quarry work. When in operation, the drill may be raised from the wheels by means of the jack-screws represented. There are two sets of journals, and by shifting the wheels it can be moved in different directions. By the use of this machine great works become easy that could hardly be undertaken with the appliances of hand labor. Having the hole bored to a suitable depth, to load it, fill about one fourth or one third of it with powder, according to the nature of the stone. The charge for a depth of 18 inches is from 8 to 12 ounces. To tamp and prime the blast-hole, the needle is first introduced, plunging it well into the powder and placing it on the smoothest side of the hole; then a layer of clay is laid on the powder, and is closely pressed down with the tamping-bar. Other similar layers are then laid, or layers of brick reduced to small bits, the needle being turned repeatedly. It is usual to press down the first layers with a bar of wood, the helve of a tool, for instance, and the latter ones with the iron tamping-bar. When the hole is thus filled up, a small shell of clay is formed round the needle, which is then withdrawn, the hole left by it is filled with fine powder, and it is fired with a monk or a piece of port-fire. The use of the needle is often dispensed with, in which case the priming is rolled up in a sheet of brown paper, or it is introduced in straw-stalks thrust into one another. This priming is placed in the hole at the same time as the charge, so that it may penetrate well into the latter. The tamping is then executed as before. The use of the tamping-bar and the ordinary tamping may also be dispensed with, the hole being filled over the charge with very fine dry sand, poured in without any pressure.



Burleigh Rock-drill.

The many accidents that have happened in priming blasts have led to the invention of priming-fuses, which are made to burn somewhat in the same way as the fuse in the small Chinese fire-cracker. Their use is far safer than any of the former methods. For blasts under water, the charge is inserted in a water-tight tin case and fired either by a galvanic current or a priming-fuse, which is protected from the water by a small tube connected with the charge, and leading to the surface of the water. The result of many experiments has shown that in blasting rock a large portion of the powder—nearly half—may be saved, by mixing with the remaining part fine, dry sawdust of elm or beech. In blasts exploded in this way the effect is not the same as when the full charge of powder is used; the rock splits into fewer and larger pieces, and to finish dividing them a more frequent use of the sledge-hammer is required.

BLAZING-OFF.—Tempering by means of burning oil or tallow spread on the spring or blade, which is heated over a fire.

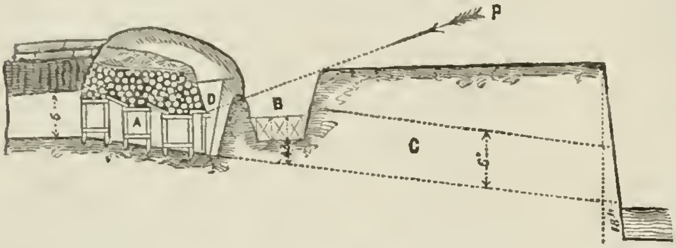
BLAZON — BLAZONRY.— These heraldic terms originated in the custom of blowing a trumpet to announce the arrival of a knight, or his entrance into the lists at a joust or tournament. The blast was answered by the heralds, who described aloud and explained the arms borne by the knight. Blazon and blazonry thus came to signify the art of describing, in technical terms, the objects (or charges, as they are called) borne in arms—their positions, gestures, tinctures, etc., and the manner of arranging them on the shield. As Heraldry, though an entirely arbitrary, is a very accurate science, the rules of blazoning are observed on all occasions with the most rigid precision. The following are the most important: 1. In blazoning or describing a coat of arms, it is necessary to begin with the field, mentioning the lines by which it is divided—*per pale, per fess*, etc., if such there be—and noticing if they are *indented, engrailed*, or the like, it being taken for granted that they are straight, unless the contrary be mentioned. 2. There must be no unnecessary repetition in blazoning; thus, where the field is blue, and the charges yellow, we should say, *azure, a crescent between three stars, or*, thereby implying that both the crescent and the stars are *or*. 3. For the same reason, where a color has been already mentioned, and it is necessary, in order to avoid ambiguity, to repeat it in describing a subsequent charge, we say, *of the first*, or *of the second*, as the case may be. Thus, we should say, *azure on a saltire argent, three water bougets of the first*, thus avoiding the repetition of the word azure. 4. Again, recurring to our first example, it would be an error to say, *three stars with a crescent between them*, because we must always begin with the charge which lies nearest the center of the shield. 5. Where the charges are of the natural color of the objects or animals represented, in place of describing the color, you simply say *proper*—i.e., of the proper or natural color. 6. Another general rule in blazoning, or rather in marshaling coat-armor, is, that *metal shall never be placed upon metal, nor color upon color*. The rules for blazoning separate charges, whether animate or inanimate, are indicated in the descriptions which will be found of them under their respective heads. See *Heraldry*.

BLECHSCHIENEN.—Thin metal plates which the ancient Gauls placed upon the buff coats of the infantry, between the buff and the lining. Also written *Blechstreifen*.

BLEUS.—A name given to the soldiers of the Republic, by the Royalists, during the wars of La Vendée, on account of their uniform.

BLINDAGE.—When a trench has to be pushed forward in a position where the command of the dangerous point is so great that it cannot be sheltered from the plunging fire by traverses, it is covered on the top and on the sides by fascines and earth supported by a framework, and is termed a *blindage*. The frames used, termed *blindage-frames*, are composed of two uprights or stanchions of 5-inch scantling, each 8 feet 6 inches long and pointed at both ends; and two horizontal pieces of the same-sized scantling, each 3 feet 4 inches long. The horizontal pieces are notched upon the stanchions at 12 inches from each end. The width of the frame from out to out is 3 feet 4 inches; the distance between the horizontal pieces from out to out, 6 feet.

This method of obtaining cover is principally requisite in trenches which descend towards the dangerous point; like the passages which lead from the trenches on the glacis into the covered-way, or to the bottoms of shallow ditches. The manner of forming the blindage is to set up a row of blindage-frames along each side of the trench or passages; to connect the two rows at top by like frames laid across the line of the trench; to cover the top frames by fascines and earth; and to fill in between the side frames and the sides of the trench with fascines. The trench is made by the double sap. Its width at bottom is 7 feet 6 inches; the width between the frames, 6 feet. The frames and fascines of the blindage are gradually placed as the trench advances, the latter preceding the former about 5 feet. The work is begun by placing an upright frame on each side; the two are



Longitudinal Section of Blindage Descent into Covered-way. A, Blindage-frames; B, Covered-way; C, Gallery Descent to Ditch; O, P, Direction of besieged fire coming over end of Traverse.

next connected by a frame on top, one side of which is lodged on the top cross-pieces of the upright frames, and the other supported by two auxiliary frames until the next two upright frames are placed; the fascines are then thrown over the top frame to the depth of about 2 feet, and these are covered with earth or raw hides, to prevent their being set on fire. Fascines are at the same time placed in on the sides.

The slope given to the bottom of a blinded descent should not be greater than one perpendicular to four base. When the descent is to a covered-way, the bottom of it should come out in the covered-way at 43 inches below its terre-plein; this will serve to determine the point of departure, the slope being fixed, which should be five feet below the surface of the glacis, so that when the blindage is put up at this point the top of it shall not be above the level of the parapet of the trench. A horizontal landing about 8 feet in breadth is made at the entrance of the blindage; and this is connected with the bottom of the trench by two ramps of one sixth.

The point selected for a blinded descent into a covered-way is usually at the end of a traverse of the covered-way; as the traverse will thus serve to cover the outlet of the blindage into the covered-way from a plunging fire in front.

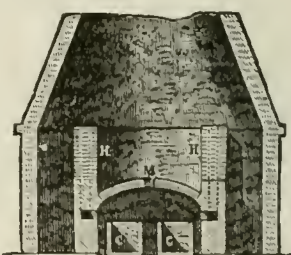
BLINDED BATTERIES.—In view of the great improvement in range, and the accuracy of fire of rifled guns, and of the greatly increased amount of both guns and mortars shown in the more recent sieges, the question of armored parapets and of bomb-proof blinds for the protection of the guns of the batteries in the position of the second parallel is one demanding consideration. When the batteries are not exposed to flank or very oblique slant views, chambers or casemates of timber, with strong bomb-proof roofs and sides with sufficient cover and strength to resist any chance shots, might be easily constructed, restricting the dimensions of each casemate to what will be strictly requisite for the maneuvers of the gun in it.

The entire front of the battery might be guarded from direct shot, particularly of elongated projectiles, by laying heavy logs or iron rails in an inclined position against the exterior slope and covering them with sand-bags, leaving only enough embrasure opening in front, both horizontally and vertically, for the field of fire wanted. Considering the range of these batteries at this distance of the second parallel, they might be sunk, so as to place them in greater security and to effect their construction more readily. See *Batteries*.

BLINDS.—Shutters of an embrasure; they are musket-proof, and at a siege, at the discretion of the Officer Commanding the Artillery, are made up by the Engineer Department from materials available on the spot. In the Crimea, coils of rope run round the chase of the gun were used in addition to the ordinary blind, to protect the gunners from the fire of riflemen when laying the gun.

BLIND SHELLS.—Shells which do not explode on impact, or at the time it is intended they should. Several causes are attributed to this defect, among them the imperfect manufacture of the fuse, the insecure manner of fitting it in the shell, shrinkage of the composition, whereby the fuse is unable to act and consequently does not ignite, and various other causes.

BLISTERED STEEL.—This variety of steel is prepared by exposing alternate layers of bar-iron and charcoal in a close furnace for several days. The purpose for which this steel is to be used determines the degree of carbonization. The best qualities of iron (Russian and Swedish) are used for the finest kinds of steel. This is the kind of steel from which, by hammering, rolling, etc., certain qualities of tools and files are fashioned. When broken up, piled, and welded under the hammer, it forms *shear-steel*, from which a finer class of tools is made, and when melted in crucibles it forms the finest kind of *cast-steel* for cutlery. Blister-steel is made from bar-iron of superior quality by a process of *cementation*, and the furnace employed for the purpose is termed a converting-furnace. This furnace is dome-shaped and inclosed in a conical jacket of brick-work, which serves to carry off the smoke from the flues, as shown in the drawing. The hearth of the furnace is divided in two parts by the grate, G, traversing the whole length of the furnace, in which a coal-fire is maintained, the flame of which is made to circulate around the fire-clay chests or pots, C, placed one on each side of the grate, before escaping through the flues in the wall, H, and through the opening, M. Into each of these pots layers of the purest malleable iron bars and layers of powdered charcoal are packed horizontally, one upon the other, to a proper height and quantity, according to the size of the pots, leaving room every way for the expansion of the metal when it becomes heated. The bars are cut to certain lengths, according to the lengths of the pots. After the packing of the pots is completed, the tops are covered with a bed of sand or clay, to confine the carbon and exclude the air. All the open spaces of the furnace are then closed, and the fire kindled. The heat is kept up for a week or ten days, according to the degree of hardness required, the hardest quality for melting purposes requiring the longest time. When the bars are removed after cooling, they are found to have undergone a remarkable change. They are no longer tough, but quite brittle and fusible, and covered over with blisters. During the process the iron absorbs and combines with from a half to one and a half per cent of carbon. The blisters are supposed to be due



Converting-furnace.

to the evolution of carbonic oxide arising from the combination of carbon with a trace of oxygen existing in the iron.

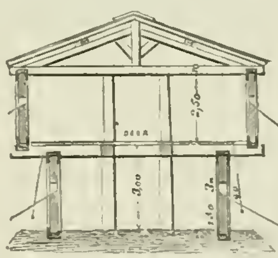
Several bars of *blistered steel* being welded together, and the process being repeated, *shear-steel* is the result; this being broken in pieces, and melted in a crucible, forms *cast-steel*, which possesses equality of texture and a capability of being rendered extremely hard, as well as of taking a fine polish. The Bessemer process of making steel consists in blowing atmospheric air into the melted pig-iron in the converting-vessel, and this operation is continued until the oxygen has effected a combination with all the carbon, except the quantity required to form steel. It has also been manufactured in such a way that the bars contain cores of iron, this gives all the hardness of steel and the tenacity of iron; and prevents articles made of it from breaking off short, as they frequently do, when formed only of hardened steel. See *Cementation* and *Steel*.

BLOCKADE.—1. In a military point of view, blockade is an operation for capturing an enemy's town or fortress without a bombardment or regular siege. The attacking party throws up works on the neighboring heights and roads; these works may be redoubts, for 200 or 300 men each, raised around at distances of 1000 or 1500 yards asunder; or they may assume other forms, according to the circumstances of each case. The rest of the besieging force remains under cover in villages, or in a temporary camp, ready to repel any sortie attempted by the besieged. The whole purpose in view is to prevent the besieged from receiving supplies of any kind, in order that, when the food or the ammunition is exhausted, they may be compelled to surrender. Fortresses situated on steep and rocky eminences, difficult to conquer by bombardment or assault, may often be reduced by blockade; because the roads or paths for the reception of supplies are few, and can be watched by a small number of troops. Towns situated on a plain are less frequently invested. If the inhabitants be numerous and commercial, they will soon be impatient of the restraint produced by a blockade, and may compel or induce the Governor to adopt a plan opposed to his wishes as a soldier. If, however, a resistance be determined on, the Governor sends out of the town as many non-combatants as possible; all the stores are collected in bomb-proof receptacles; economy is observed in the consumption of food; all the people within the walls are placed under military rules; and the Governor endeavors, by frequent sorties, to prevent the besiegers from making too close an investment of the place.

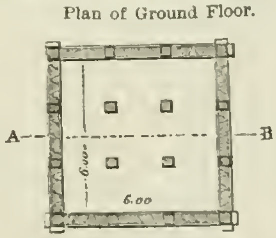
2. In international law, blockade is the right, in time of war, of rendering intercourse with an enemy's port unlawful on the part of neutrals; and it is carried into effect by an armed force (ships of war), which blocks up and bars export or import to or from the place blockaded. This right is described by all writers on the law of nations as clear and incontrovertible, having its origin in the soundest principles of maritime jurisprudence, sanctioned by the practice of the best times. It is explained on the reasonable theory that if a potentate or government lays siege to a place, or simply blockades it, such potentate or government has a right to prevent any other power, or representative, or subject of such power, from entering, and to treat as an enemy any one who attempts to enter the blockaded place, or in any way assists the besieged, for such a person opposes the undertaking and contributes to the miscarriage of it. To be valid, a blockade must be accompanied by actual investment of the place, and it may be more or less rigorous, either for the purpose of watching the operations of the enemy, or, on a more extended scale, to cut off all access of neutral vessels to that interdicted place, which is strictly and properly a blockade; for the former is, in truth, no blockade at all, as far as neutrals are concerned. But to be binding on neutrals, it ought to be shown that they have knowledge or may be presumed to know of the blockade; and this knowledge may arise in two ways—either by such a public and formal notification as we have already described, or by the notoriety of the fact. Yet it is at all times most convenient that the blockade should be declared in a public and distinct manner, instead of being left to creep out from the consequences produced by it; and the effect of such notification to the neutral government is clearly to include all the individuals subject to the latter. The breach of blockade may be either by coming out of the blockaded port or going in; such breach, however, may sometimes be excusable. It has been decided that intoxication on the part of the master of a ship will not be received as an excuse. That breach of blockade subjects the property employed for that purpose to confiscation is an established rule of the law of nations, and is universally acknowledged by all civilized governments. The violation of blockade by the master, however, affects the ship, but not the cargo, unless the cargo is the property of the same owner, or unless the owner of the cargo is cognizant of the intended violation. On the proclamation of peace, or from any political or belligerent cause, the continuance of the investment may cease to be necessary, and the blockade is then said to be *raised*. The blockading force then retires, and the port is open as before to all other nations.

BLOCK-BATTERY.—In gunnery, a wooden battery for two or more small pieces, mounted on wheels, and movable from place to place: adapted to fire *en barbette*, in the galleries and casemates, etc., where room is wanted.

BLOCK-HOUSE.—In inclosed works a place of retreat, into which the troops may retire in safety after a vigorous defense of the main work, will remove the



Plan of Ground Floor.



Block-house.

fears of the garrison for the consequences of a successful attack of the enemy, and will inspire them with confidence to hold out to the last moment. This interior work, which may very properly be termed the *keep*, can only be applied to works of large interior capacity. It may be formed of earth, or consist simply of a space inclosed by a defensive stockade, or palisading. In either case it should be about four feet higher than the main work, to prevent the enemy from obtaining a plunging fire in it from the parapet of the main work. The best arrangement for the keep is the construction termed the *block-house*. This work is made of heavy timber, either squared on two sides or four; the pieces which form the sides of the block-house are either laid horizontally, and halved together at the ends, like an ordinary log-house, or else they are placed vertically, side by side, and connected at top by a cap-sill. The sides are arranged with loop-hole defenses; and the top is formed by laying heavy logs, side by side, of the same thickness as those used for the sides, and covering them with earth to the depth of three feet.

The plan of a block-house is selected by the same general rules which are used for selecting the trace of a field-work. It may be square, rectangular, octagonal, and even cruciform in plan, according to the locality in which it is placed and the fire which it has to deliver. The dimensions should be sufficient to allow sleeping accommodations for the men who are to occupy it; and in some cases allowance should be made for other accommodations. Its interior dimensions should give at least a height of six feet in the clear for the rooms; a height of eight or nine feet gives better accommodations and better ventilation. The width of the interior should not be less than nine feet in the clear, as this is the least distance which can be used and give room for a passageway and a row of bunks. The length will depend upon the number of men it has to accommodate, after the width has been assumed. Block-houses must be made strong enough to resist the projectiles which may strike them, and should be proof against fire and splinters. They should be free from dampness, and should be well ventilated. The conditions given for a bomb-proof are applicable to the block-house, with the additional one of arranging its walls for defense.

It has been proposed to place a slight parapet of earth on top of the block-house. It is thought that this accumulation of earth would be too heavy for the timbers, independently of leaving but little space for the defense. Perhaps a better arrangement might be made on top, similar to a defensive stockade, the uprights being secured at bottom, between two pieces resting on the top pieces, and held firm by an arrangement of riband pieces and braces. It has also been proposed to place the interior and exterior rows of uprights three feet apart, and to fill in between them with closely packed earth, for a defense against artillery. This method has been tried, and was found to be less solid than the one here laid down, independently of being more difficult to construct. The top pieces should in no case project more than twelve inches beyond the sides, to admit of logs, etc., being rolled over on the enemy.

Timber block-houses were used frequently in the War of 1861–5 in isolated spots, as independent works. In these places they were, as a rule, exposed to attack only from infantry or cavalry, or a few pieces of field-artillery. It was found from experience that it required a thickness of forty inches of solid timber to resist the projectiles of field-guns. These isolated block-houses were frequently built two stories high. The upper story was usually placed so as to have its sides make an angle with the sides of the lower story. By this arrangement the corners of the upper story projected over the sides of the lower. This arrangement of the upper story removed the dead space near the sides of the lower story, and the sector without fire in front of the angles. Block-houses exposed to artillery-fire should not have a second story.

The drawing shows the construction of a block-house, with dimensions in meters, used by the French in Algiers; or it may be built of logs 18 inches square on the ground-floor and 12 inches square in the upper story. Height of each story 10 feet; loop-holed; the upper story projecting all round, beyond the ground-story, as machicoulis. Hatches are made in the roof for the escape of smoke, and are grated. See *American Block-house*.

BLOCKS.—1. *Blocks* are of two kinds, *made* and *mortised*. A *made* block consists of four parts—the *shell*, or outside; the *sheave*, or wheel on which the rope turns; the *pin*, or axle on which the wheel turns; and the *strap*, either of rope or iron, which encircles the whole and keeps it in its place. The sheave is generally strengthened by letting in a piece of iron or brass at the center, called a *bush*. Nearly all heavy blocks for ordnance purposes are made with iron shells and brass sheaves. A *mortised block* is made of a single block of wood, mortised out to receive a sheave. All blocks are single, double, or threefold, according to the number of sheaves in them. There are blocks that have no sheaves, to wit: a *bull's eye*, which is a wooden thimble without a sheave, having a hole through the center and a groove round it; and a *dead-eye*, which is a solid block of wood made in a circular form, with a groove round it, and three holes bored through it, for the lanyards to reeve through. *Snatch-blocks* are single blocks, with a notch cut in one cheek, just below the sheave, so as to receive the bight of a fall

Mortised Block.

without the trouble of reeving and unreeving the whole. They are generally iron-bound and have a hook at one end. A *tail-block* is a single block, strapped with an eye-splice, and having a long end left, by which to make the block fast temporarily to the rigging. This tail is usually selvaged, or else the strands are opened and laid up into sennit, as for a gasket.

Blocks were made by hand until about a century ago. But mere workers in wood could not produce them; it required unusual skill and practice to fashion the several pieces and put them together so as to possess the requisite strength and facility in working. In 1781 a Mr. Taylor began to make the sheaves and shells of blocks by a process which he had invented. He made all the blocks for the Royal navy until the expiration of his patent-rights. The Admiralty then commenced the manufacture on their own account. In 1801 Mr. (afterwards Sir) Mark Isambard Brunel submitted to the Admiralty a working-model of a very beautiful system of machinery for block-making; it was accepted, and the inventor engaged to set up the apparatus at Portsmouth. So intricate was the machinery, and so great the difficulty in procuring the several working-parts from the machinists of those days, that it was not until the year 1808 that the system was put into effective operation. It was then, however, so perfect that very few additions or improvements have since been needed. The machinery made blocks more accurately than they had ever been made by hand, and with the aid of ordinary workmen only. It could effect £50,000 worth of work in a year, or 140,000 blocks, by the assistance of ten men attending the machine. Duplicate machinery was made for Chatham. Brunel received £20,000 for his invention and for his personal superintendence until the machinery was brought into working-order; this sum was money well laid out, for the machine saved to the country more than £20,000 a year, in the busy warlike period from 1808 to 1815. The machinery itself is too complicated to be described except at a length incompatible with the limits of this work; but it may be stated in a general way that the system is made up chiefly of saws and lathes, combined with great ingenuity. The blocks are made of elm, and the sheaves of lignum vitæ; the pins are of iron, carefully prepared to avoid friction as much as possible.

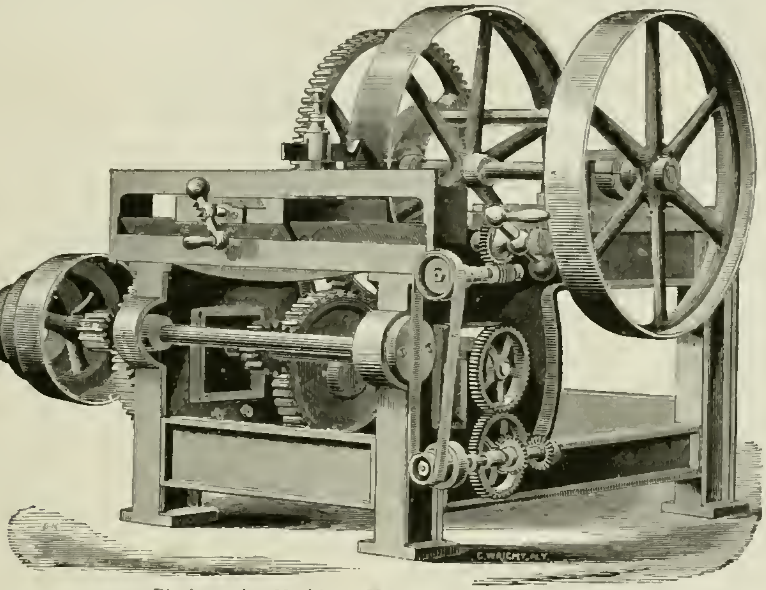
The drawing shows a most excellent block-turning machine manufactured by Messrs. Manning, Maxwell & Moore, New York. It is generally employed at the armories, and has a capacity for blocks up to 50 inches diameter. The latest designed block-turning lathe has a large cone-pulley, with 6 steps for a wide belt, which transmits the power through tangent gearing (accurately cut) to the main spindle; this is an extraordinarily steady and powerful method of driving, and is held in high estimation in England, where it has been tested through a range of work that demands the utmost steadiness, such as cylinder-boring, etc. The carrier-plate is of the equalizing type, obviating unequal and lateral strains. On each side of the solid bed-piece are placed rests which slide in and out on graduated surfaces to suit the diameter of the pulley to be turned; these rests can be set angularly to get any desired degree of "crown"; tools are thus operated on both sides of the machine. The feeds are continuous, not intermittent (a ratchet and a pawl give an intermittent feed). The feeds can be instantly engaged, disengaged, or changed. Another admirable feature of this tool is that the spindle of the cone-pulley runs at so much higher velocity than the main spindle that its speed is suitable for polishing when the latter is turning; a steel mandrel and a suitable rest are provided for polishing. This arrangement secures a combination of machines. The counter-shaft has two pulleys 20 inches in diameter, 5¼ inches face, which should run 130 revolutions per minute. See *Mechanical Maneuvers* and *Tackles*.

2. Rectangular prisms of wood employed extensively in all operations connected with the movements of heavy artillery. They are usually 8 inches square and 20 inches long.

BLOCK-SHIP.—A ship of war too old or too slow in sailing to render efficient service in action out at sea, but useful as a defense in great ports and naval arsenals. Since war-steamers have almost superseded the old sailing men-of-war, the latter are of little service except as block-ships, or for training-ships. The number of block-ships in the British navy in 1859 was about ten.

BLOCK-TIN.—Tin which has undergone refining, either by *liquation* or *poling*, when it is run into blocks, each weighing about 3 cwt. Tin thus treated is found to form in the melting-basin three strata, of which the top stratum is most pure, the bottom most impure, and the middle of average purity. The best qualities of this metal are the Banca, the Cornish, and the Spanish tin. This metal is mixed with copper to form bronze.

BLOCK-TRAIL.—In artillery, that pattern of gun-carriage the trail of which is formed of one beam, or two beams tabled one into the other. It is stated in Lieutenant-colonel Owen's *Modern Artillery* that this nature of carriage was invented in 1792 by Sir W. Congreve. It has now been superseded in lately constructed wrought-iron carriages by the bracket-trail.



Block-turning Machine. Manning, Maxwell & Moore.

BLOMARY—BLOOMARY.—A furnace for transforming pig-iron to wrought or malleable iron, or for making such iron directly from ore. When ore is used, a mass of iron called a "bloom" is produced, instead of the impure pig-iron that runs from the melted metal in a blast-furnace. The blomary process is one of the oldest in iron-working, and is used in rude forms in some still barbarous countries. The best of modern blomaries are the German and the Catalan (Spanish) furnaces, in which ores are reduced chiefly by means of charcoal. The best of ore should be used, as the waste is much greater in poor ore. In the Catalan, the charcoal, with a large part of the iron, is heaped on a square hearth opposite to the tuyere, charcoal and fine ore being added from time to time, while a moderate blast is kept up and the mass occasionally stirred. In about six hours the iron settles to the bottom, is taken out in a mass, and forged into a bloom. For the German or more common bloom, the ore is pounded fine and thrown in small quantities upon a charcoal-fire, with either hot or cold blast, hot being much the better. The metal settles to the bottom, and is drawn off at intervals, and hammered into blooms. The process is available in places where wood (for charcoal) and good iron-ore are found near each other. Iron so made is of the best quality, and is very desirable for converting into steel.

BLONDEL SYSTEM OF FORTIFICATION.—In this system the bastions are large and acute; their flanks are long and triple. The bastions are covered by counterguards, whose ditches, like those of the ravelins, are defended by low batteries. Small ravelins are substituted for the reduit of the re-entering place of arms. It is weak in outline and costly in masonry. See *Fortification*.

BLOOD-HOUND.—A variety of hound remarkable for its exquisite scent and for its great sagacity and perseverance in tracking any object to the pursuit of which it has been trained. It derives its name from its original common employment in the chase, either to track a wounded animal or to discover the lair of a beast of prey. It was also formerly called, both in England and in Scotland, *sleut-hound* or *sleuth-hound* from the Saxon *sleut*, the track of a deer. The poetical histories of Bruce and Wallace describe these heroes as occasionally tracked by blood-hounds, when they were skulking from their enemies. The blood-hound was at a later period much used to guide in the pursuit of cattle carried off in border raids; it has been frequently used for the pursuit of felons and of deer-stealers; and latterly, in America, for the capture of fugitive slaves and prisoners of war—an employment of its powers which has contributed not a little to render its name odious to many philanthropists. Terrible ideas are also, probably, suggested by the name itself, although the blood-hound is by no means a particularly ferocious kind of dog, and when employed in the pursuit of human beings can be trained to detain them as prisoners without offering to injure them. The true blood-hound is taller and also stronger in proportion and of more compact figure than a fox hound, muscular and broad-chested, with large pendulous ears, large pendulous upper lips, and an expression of face which is variously described as "thoughtful," "noble," and "stern." The original color is said to have been a deep tan, clouded with black. The color appears to have been one of the chief distinctions between the blood-hound and the talbot, but it is not improbable that this name was originally common to all blood-hounds. Many interesting anecdotes are recorded of the perseverance and success of blood-hounds in following a track upon which they have been set, even when it has led them through much-frequented roads.—The Cuban blood-hound, which is much employed in the pursuit of felons and of fugitive slaves in Cuba, differs considerably from the true blood-hound of Britain and of the Continent of Europe, being more fierce and having more resemblance to the bull-dog, and probably a connection with that or some similar race. Many of these dogs were imported into Jamaica in 1796, to be employed in suppressing the Maroon Insurrection, but the terror occasioned by their arrival produced this effect without their actual employment. It was this kind of blood-hound which was chiefly introduced into the former Slave States of North America.

BLOOD'S PONTONS.—Flat-bottom boats, made of light wooden frames covered by coatings of canvas, wood, cork, and leather, cemented together. Their length is 21 feet, breadth 5½ feet, weight 850 lbs., and buoyancy 5½ tons. The bridge will readily bear a 64-pounder gun. One wagon conveys one ponton and the superstructure for 15 feet of bridge. The bridge can be constructed at the rate of 200 yards per hour. See *Blanchard Pontons*.

BLOOM CAMPAIGN EQUIPMENT.—The difficult problem of drawing the proper line between the number of articles that should be in hand, when the engagement ensues, and the weight that should be transported on the person, has received much attention of late. The excellent campaign equipment devised by J. E. Bloom, Esq., late of the United States Artillery, is the nearest approach to perfection, as yet. By this device the center of gravity of the soldier remains nearly normal, and the strain falls upon those portions of the body which can best bear them. It seems that the principal objection to the "roll" as worn during the late war was that the weight fell upon one side of the body, thus heating it, etc. In Mr. Bloom's system of equipment this objection is entirely overcome, and the soldier is enabled to transport the following with great facility: one hundred cartridges (cal. 45), one blanket, one shelter-tent, one overcoat, one pair pants, one pair drawers, one undershirt, one woolen shirt, one pair socks, one pair shoes, towel, soap, etc., in addition to his rifle. The equipment consists in a system of supporting straps, by means of which the weight to be carried is directly transferred to and supported equally by the shoulders, without producing any horizontal pressure upon the chest. This object is accomplished by means of a yoke, composed of two leather straps, passing over the shoulders and joined by the same rivets at their ends—front and rear (opposite to the extremity of the sternum bone)—both to plates or stirrups, and also to a double blanket-strap, for securing the blankets and articles rolled therein. The blanket-roll is adjusted so as to fully clear, by an inch, the shoulder over which it passes, being thus suspended from a central point front and rear, upon a line passing through the center of gravity of the body—thus causing such a disposition of these articles as not to disturb the equilibrium of the body.

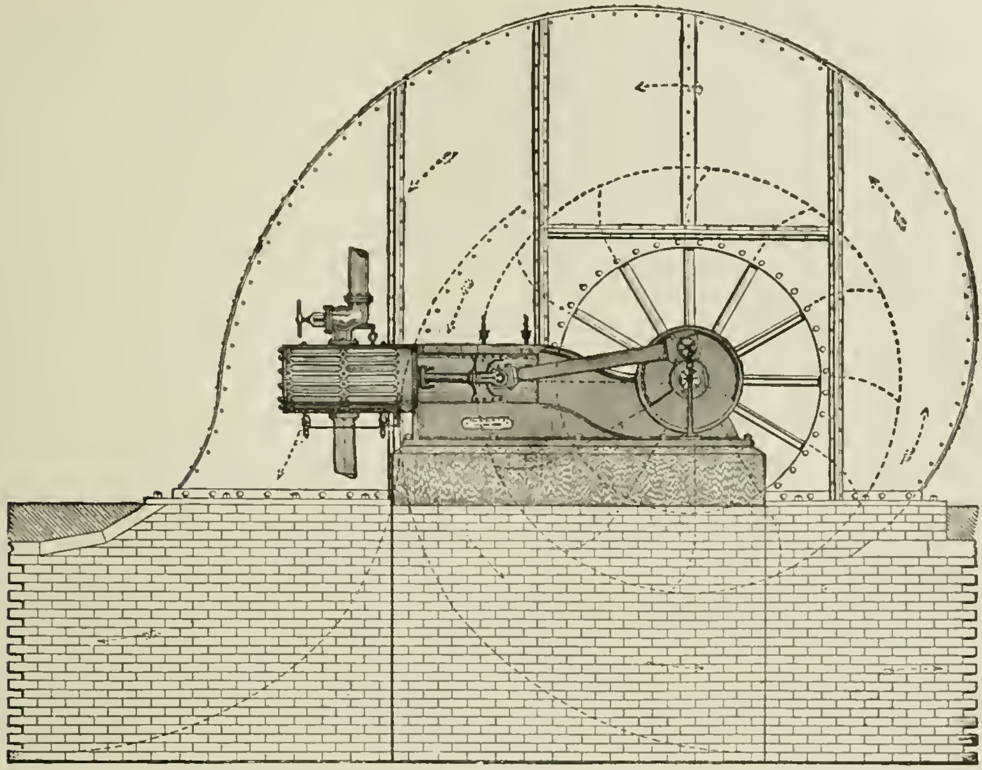
The weight of the cartridge-belt, of any variety, is supported from stirrups, both at front and back, by means of hooks, or hook-plates, which are connected with the belt through adjustable straps and snap-hooks. The haversack, canteen, gamebags, etc., are likewise suspended from side slots in the stirrups by means of straps. The blanket-roll, when firmly made and adjusted, exerts more than sufficient *outward thrust* to counteract all inward strains (which would otherwise fall upon the chest) due to the weight of the "roll," ammunition-belt, etc. This should be passed over the left shoulder when the soldier is right-handed or fires from the right shoulder, and *vice versa*. The following advantages of such an equipment are apparent: 1. Lightness and simplicity; and, being practically in one piece, there are no parts to be lost by the most careless. 2. Facility and quickness of slinging and unslinging. 3. It does not interfere with the action of the soldier, or the natural equilibrium of his body. 4. It does not heat the soldier; but allows him to sleep with all accouterments upon the person—the upper part of the "roll" forming a pillow for the head. The European soldier, on going into action, is allowed the following ammunition: France, 92; Germany, 117; Russia, 120; England, 100; Austria, 119. The equipment described will enable him to carry 100 rounds, in addition to his kit, etc., with ease and safety. See *Equipments*.

BLOOMFIELD GUN.—An ordinary cast-iron gun, with a charge of one third the weight of the shot. It has from 1¾ to 4 cwt. of metal to every 1 lb. of shot. The 32-pdr., of 56 cwt., and 24-pdr., of 50 cwt., are still in the English service, as well as some other guns of this pattern.

BLOUSE—BLOWSE.—A part of the undress uniform. It is usually employed for fatigues, marches, squad and company drills, and other drills when authorized by the Commanding Officer, and for ordinary wear. In the United States army, it is a sack-coat of dark blue cloth or serge; falling collar; single-breasted, with five buttons in front, same as those worn on the dress-coat. The skirt extends from one third to two thirds the distance from the hip-joint to the bend of the knee. The shoulder-straps are always worn with this coat. A Chaplain wears a plain black frock coat with standing collar; one row of nine black buttons on the breast, with "herring-bone" of black braid around the buttons and button-holes. Officers are permitted to wear a plain dark blue body-coat, with the button designating their respective corps, regiments, or departments, without any other mark or ornament upon it. This coat, however, is not to be considered as a dress for any military purpose. Enlisted men wear a dark blue blouse of navy flannel, according to the pattern deposited in the Quartermaster-general's Office. Blouses for winter wear are lined. See *Dress-coats*.

BLOWER.—A machine for creating an artificial current of air by pressure. A *plenum* engine, as contradistinguished from a *vacuum* engine, such as an aspirator. Blowers are used to increase draughts in furnaces; to furnish vital air to close and fetid places, as mines, poorly ventilated casemates, etc.; to furnish a current of warmed, cooled, moistened, or medicated air to hospitals or closely occupied barracks; to furnish a drying atmosphere in powder-mills and lumber-kilns; to raise fluids on the principle of the Giffard injector, etc.

The earlier modern forms of machine-blowers consist of cylinders with pistons, the differences between them consisting principally in the means for communicating motion and for securing a uniform blast. In the blowers at Woolwich, England, the air is forced from the blowing-cylinders into a reservoir,



Sturtevant Blower.

whence it issues by the force of its compression. The beams of the pistons are so connected that when one is at the top of the stroke another is midway of its cylinder and the third at its lowest point, maintaining very nearly uniform pressure in a wind-chest below with which each cylinder communicates. Blowers on the fan-principle are the favorite subjects of the exercise of the ingenuity of modern inventors in this line. In these the air is admitted through an aperture at or near the axis of the rotating fan, whence it is driven toward the periphery by means of curved arms, and discharged through an opening in the case. The Sturtevant blower, in its many varieties, is acknowledged to be superior to all others of its kind, and is much used by the United States Government, as also in foreign armories. The drawing shows a form of this blower especially adapted for use where air is to be carried any distance in underground ducts, and is much used for forcing fresh air into and taking foul air out of hospitals and apartments needing ventilation. These blowers are of all descriptions to suit every possible situation and kind of work, In nearly all cases where the blast-pipe leads directly upward from the blower it is better to have the blower built with upward blast, with the mouth pointing upward instead of horizontally. It saves making an elbow, which would have to be used in the case of a horizontal-blast blower; and in most cases where elbows are put on to the horizontal blast, contractors try to economize room, and by so doing make a very short elbow, which in some cases reduces the force of the blast about one fifth, necessitating nearly double the power to do the same work as would be required with the up-blast blower and straight pipe. These blowers may, for example, be used with advantage where the space under the floor is to be ventilated, and the foul air discharged upward through the roof or into a chimney, or when the blower is attached to a heater and located where floor-space is very valuable, and the hot blast used in dryers overhead or on the next floor above.

The pressure-blowers for cupola-furnaces and forges are made of steel, and are built very strong and heavy. The following table shows the melting capacities, speeds, etc., of blowers of various sizes:

No. of the blower.	Diam. in inches inside of cupola.	Melting capacity per hour in pounds.	Number of square inches of blast.	Cubic feet of air per minute.	Speed.	Pressure in ounces of blast	Horse-power req'ired	Power Saved by Reducing the Speed and Pressure of Blast.					
								Speed.	Oz. Pres.	H. P.	Speed.	Oz. Pres.	H. P.
1........	22	1,200	4 (One square inch of blast is sufficient for one forge-fire, or ninety square inches area of cupola-furnaces.)	324	4135	5	0.5						
2........	26	1,900	5.7	507	3756	6	1	3445	5	0.8	3100	4	0.6
3........	30	2,880	8	768	3250	7	1.8	3000	6	1 5	2750	5	1.1
4........	35	4,130	10.7	1,102	3100	8	3	2900	7	2.5	2700	6	2
5........	40	6,178	14.2	1,646	2900	10	5.5	2560	8	4	2390	7	3 3
6........	46	8,900	18.7	2,375	2820	12	9.7	2550	10	7 4	2260	8	5.3
7........	53	12,[illegible]00	24.3	3,353	2600	14	16	2380	12	12.7	2150	10	9.4
8........	60	16,560	32	4,416	2270	14	22	2100	12	16 7	1900	10	12.7
9........	72	23,800	43	6,364	2100	16	35	1960	14	28 4	1800	12	23.5
10........	84	33,300	60	8,880	1815	16	48	1700	14	39.6	1566	12	31.7

The speed given is regulated so as to give the pressure of blast stated in ounces per square inch. The number of cubic feet of air per minute given against each size cupola is the result of numerous tests taken on cupolas. The term "square inches of blast" refers to the area of a proper-shaped mouth-piece discharging blast into the open air. The melting capacity per hour in pounds of iron is made up from an average of tests on a few of the best cupolas found, and is reliable in cases where the cupolas are well constructed and driven with the greatest force of blast given in the table. That portion of the table headed "Power saved by reducing the speed and pressure of blast" shows that in foundries, where a strong blast is not desirable, the blower can be run and do good work with very much less power. See *Fanner*, *Iron*, and *Steam-fan*.

BLOW-GUN.—A sort of air-gun used by the Barbados Indians of Brazil and other aborigines of South America. A similar contrivance is employed by some of the Malays, by whom it is called "sumpitan." The arrows are about fifty inches long, made of a yellow reed, and tipped with hard wood, which has a spike of cocourite wood poisoned. The spike is cut half through, so as to break off in the wound, that the arrow-shaft may drop and be recovered.

BLOWING-BAGS.—Bags filled with a small charge of gunpowder and coal-dust, and placed inside a common shell when it is not intended to burst the shell. The charge is ignited by means of a fuse. Blowing-bags are used in artillery-practice, to show where, if the shell had been a live shell, it would have burst.

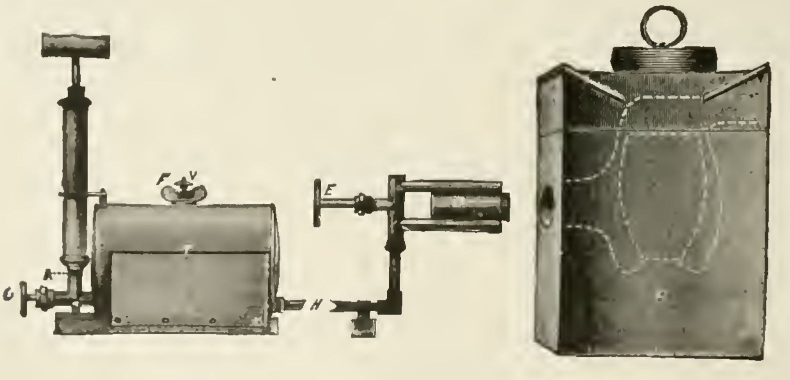
BLOWING-CHARGES.—Charges used for different natures of common shells; they are a mixture of gunpowder and coal-dust. The object of using the blowing-charge is when it is not desirable or safe to burst the shell.

BLOWING-CYLINDER.—A form of blast-engine. Smeaton introduced the blowing-cylinders at the Carron Iron-works, and by the power and volume of blast made effective the earnest and repeated attempts of the English to smelt iron by the use of the coke of pit-coal. This was in 1760, and utilized the invention of Abraham Darby, of Colebrookdale, in 1735.

BLOW-PIPE.—A small instrument used in the laboratory for soldering metals, and in analytical chemistry and mineralogy for determining the nature of substances by the action of an intense and continuous heat, its principle depending on the fact that when a jet of air or oxygen is thrown into a flame the rapidity of combustion is increased, while the effects are concentrated by diminishing the extent or space originally occupied by the flame. The blow-pipe generally consists of a conical tube of metal, about 8 inches long, closed at the wider or lower end, but open at the narrow or upper end, which latter constitutes the mouth-piece, and is turned over to admit of the lips closing perfectly round it. Near the lower end, a small tube, fitted with a finely perforated nozzle, is inserted at right angles to the large tube, the space below being intended as a chamber for condensing the moisture of the breath. Through this nozzle a fine current of air can be projected against the flame experimented with.

When a current of air from the blow-pipe is directed against a candle or gas-jet, the flame almost entirely loses its luminosity, owing to the perfect combustion of the gases evolved from the source of heat, and is projected in a lateral direction, as a long-pointed cone, consisting of three distinct parts. The first or central cone is of a dark blue color, and there the combustion is complete from the excess of air thrown in from the small nozzle. The second cone, or that immediately surrounding the first, is somewhat luminous; and here, the oxygen being insufficient for the combustion of the carbon, any metallic oxide subjected to the action of this portion of the flame is deprived of its oxygen and reduced to the condition of metal; for this reason the luminous cone is generally termed the *reducing flame* of the blow-pipe. Beyond the second cone, or where the flame comes freely in contact with the atmosphere, and abundance of oxygen is present to effect complete combustion of the gases, is a third or pale yellow envelope, containing excess of atmospheric air at a very high temperature, so that a portion of metal, such as lead or copper, placed at this point, becomes rapidly converted into its oxide: this outer part of the flame is on this account called the *oxidizing flame* of the blow-pipe.

Hoskins' Hydro-carbon Blow-pipe and Furnace are represented in the drawing. In this apparatus, much used in the armory, P is an ordinary force-pump, at the bottom of which (at A) is a valve which closes automatically upon releasing the pressure from the pump. C is a check-valve which closes the inlet to the tank, T, completely. F is the filling-screw. H is the pipe leading from the tank to the burner, D. E is the burner-regulator, terminating in a fine point, closing the orifice of the burner. B is the crucible-furnace. Upon pumping a few strokes, a pressure is created in the tank, which forces the fluid through the pipe, H, and the tubes of the burner, when it is vaporized by heating the burner, and finally issues from the fine orifice at the end of E as a highly heated gas, and burns as such with a powerful blast. After once being started, the heat of the flame passing through the burner evaporizes the fluid in the tubes, and hence it is automatic in its action. The air which is forced in is not used, and therefore it is only necessary to occasionally use the pump to maintain the pressure lessened by the consumption of the fluid, to keep up the blast.



Hoskins' Hydro-carbon Blow-pipe and Furnace.

The following are exemplifications of the difference of color communicated to the flame by different substances: salts of potash color the flame *violet;* soda, *yellow;* lithia, *purplish red;* baryta, *yellowish green;* strontia, *carmine;* lime, *brick-red;* compounds of phosphoric acid, boracic acid, and copper, *green.* The commonly occurring metallic oxides reducible by heating on charcoal alone in the inner flame of the blow-pipe are the oxides of zinc, silver, lead, copper, bismuth, and antimony; the principal ores not so reducible are the alkalies and alkaline earths, as also the oxides of iron, manganese, and chromium. The fluxes generally used in blow-pipe experiments are either carbonate of soda, borax (biborate of soda), or the ammonia-phosphate of soda, otherwise called *microcosmic salt.* The carbonate of soda, when heated on platinum wire in the oxidizing flame, forms with silica a *colorless glass;* with oxide of antimony, a *white bead*, etc. The following metals are reduced from their compounds when heated with carbonate of soda on charcoal in the inner flame of the blow-pipe, viz.: nickel, cobalt, iron, molybdenum, tungsten, copper, tin, silver, gold, and platinum. When compounds of zinc, lead, bismuth, arsenic, antimony, tellurium, and cadmium are similarly treated, these metals are also formed, but being volatile, they pass off in vapor at the high temperature to which they are exposed.

Borax, as a flux, is generally mixed with the substance under examination, and placed on platinum wire. When thus heated in either of the flames, baryta, strontia, lime, magnesia, alumina, and silica yield *colorless beads;* cobalt gives a *fine blue color;* copper, a *green;* etc. With microcosmic salt the results obtained are generally similar to those with borax, and need not be specially mentioned, as the test is applied in the same way. The blow-pipe has been long used by goldsmiths and jewelers for soldering metals, and by glass-blowers in fusing and sealing glass tubes, etc.; it has also been applied in qualitative analysis for many years, but more recently chemists (especially Plattner) have devoted their attention to its use, and have even employed it with great success in *quantitative* chemical analysis; the advantages being that only a very small quantity of material is required to operate upon, whilst the results may be obtained with great rapidity and considerable accuracy.

BLOW-PIPE AND ARROW.—A kind of weapon much used by some of the Indian tribes of South America, both in war and for killing game. It consists of a long straight tube in which a small poisoned arrow is placed and forcibly expelled by the breath. The tube or blow-pipe, called *gravatina pocuna*, etc., is 8 to 12 feet long, the bore not generally large enough to admit the little finger. It is made of reed or of the stem of a small palm. Near Pará it is in general very ingeniously and nicely made of two stems of a palm (*Iriartea setigera*) of different diameters, the one fitted into the other, in order the better to secure its perfect straightness. A *sight* is affixed to it near the end. The arrows used in that district are 15 to 18 inches long, made of the spines of another palm, sharply pointed, notched so as to break off in the wound, and their points covered with *curari* poison. A little soft down of the silk-cotton tree is twisted round each arrow, so as exactly to fit the tube. In Peru arrows of only 1½ to 2 inches long are used, and a different kind of poison seems to be employed. An accidental wound from one of these poisoned arrows not unfrequently proves fatal. In the hand of a practiced Indian the weapon is very deadly, and particularly when directed against birds sitting in the tops of high trees. As his weapon makes no noise, the hunter often empties his quiver before he gathers up the game, and does more execution than an American sportsman could with his double-barreled fowling-piece.

BLUDGEON.—A short stick, with one end loaded or thicker and heavier than the other, used as an offensive weapon.

BLUE-LIGHT.—An ornamental composition in pyrotechny. For one hundred lights the following materials are required: *niter*, 9 pounds 10 ounces; *sulphur*, 2 pounds 6¼ ounces; *red orpiment*, 11 ounces; *mealed powder*, 11 ounces. The materials should be pure, well pulverized, and thoroughly incorporated, rubbing them in the hands, and passing them several times through a fine hair-sieve. *Hemispherical cups*, of well-seasoned wood (beech, linden, etc.), with a handle 10 inches long, 1¾-inch diameter; *quick-match; paper; paste.* To prepare a blue-light, fill the cup with composition, and press it firmly in; prime the cup with quick-match, and cover the whole with cartridge-paper pasted to the bottom of the cup. The brilliancy of the light depends on the purity and thorough incorporation of the ingredients. The composition may also be driven in a paper case, and afterwards cut off to suit the required time of burning. Both ends of the case are closed with paper caps and primed with quick-match, in order that one or both ends may be lighted at pleasure. A light in which the composition is 1.5 inch in diameter can be easily distinguished at a distance of 15 miles. See *Compositions* and *Fire-works.*

BLUE PETER.—A blue flag with a white square in the center, used to signify that the ship on which it is raised, or the fleet of which that is the flagship, is about to sail. "Peter" is a barbarism for the French *partir*, a notice of departure.

BLUES.—One of the three mounted regiments of household troops. This regiment was originally raised at Oxford, and was commonly called the Oxford Blues. It is now known as the regiment of Royal Horse-guards.

BLUING.—The art of imparting a blue color to finished iron-work or steel, such as gun-locks, barrels, gun-sights, etc. The object in bluing articles, which is simply coating them with a thin film of oxide, is to prevent further oxidation from exposure to the atmosphere.

BLUNDERBUSS.—A kind of short musket with a very wide bore, sufficient to take in several shot or bullets at once. It has a limited range, but is very destructive at close quarters. As a military weapon it is chiefly of service in defending passages, doorways, staircases, etc. Some of the English and German troopers in the seventeenth century were armed with the blunderbuss; but the carbine has since nearly superseded this weapon.

BLYDE.—A kind of war-machine, which was used in ancient times to throw stones; some authors compare it to the catapult. In the year 1585, at the siege of the Castle of Rucklingen, Albert, Duke of Saxony and Lüneburg, was killed by a stone thrown from a blyde. Also written *Bly* and *Blude.*

BOARD OF ENGINEERS.—A Board consisting of not less than three officers to be designated by the Chief of Engineers, with the sanction of the Secretary of War, whose duty is to plan or revise, as may be directed by the Chief of Engineers from time to time, projects of permanent fortifications required for the defense of the territory of the United States, and works of river and harbor improvement; also to consider and report upon such other matters as may be referred to it by the Chief of Engineers. It is the duty of the Members of the Board, whenever required by the Chief of Engineers, to inspect and report upon any of the works of construction or other of the operations of the Engineer Department.

Whenever the defense or improvement of any particular locality or other work is under consideration, the local Engineer officer may be associated with the Board as a member thereof, if, in the opinion of the Chief of Engineers, this can be done consistently with his other duties. Two Members of the Board constitute a quorum for the transaction of business, but its final decisions in important matters must be sanctioned by a majority of its members. A dissenting member may present his views or project through the Board to the Chief of Engineers, with drawings and estimates. The reports of the Board are made to the

Chief of Engineers. It keeps a journal of its proceedings, and on the first day of each month reports to him the movements of its members, and a brief statement of the occupation of the assembled Board. The Chief of Engineers submits all important reports of the Board, with his views thereon, to the Secretary of War, without whose sanction no important work can be undertaken.

BOARD OF EXAMINATION.—A Board instituted in the Army to determine upon appointments in regiments, and for appointments and promotion in the Medical Staff, Engineer Corps, and Ordnance Department. All members of these Boards are army officers.

BOARD OF OFFICERS.—A number of officers assembled by military authority for the transaction of business.

BOARD OF ORDNANCE.—A Government Department formerly having the management of all affairs relating to the Artillery and Engineering Corps, and to the *matériel* of the British army. Under this precise designation, the Board no longer exists; a change having been made which requires brief explanation. The Board existed from the time of Henry VIII. until 1855, when it was abolished, its functions being vested in the Secretary of State for War as regarded *matériel*, and in the Commander-in-Chief as concerned the military command of the Artillery and Engineers. The Board of Ordnance until 1854 comprised the Master-general of the Ordnance, the Surveyor-general, the Clerk of the Ordnance, and the principal Storekeeper, all of whom were usually Members of Parliament. There was no chairman at the meetings, and the Board often consisted of only one officer. The Master-general had a veto, and was in that respect more powerful than the chief member of the Board of Admiralty; although, not having necessarily a seat in the Cabinet, he had less political power. The Board days were thrice a week; and each of the four members had control over certain Departments—the patronage of which was generally vested in him. Scarcely any improvements were made from 1828 till 1854, and the general arrangements were very defective. Of the four members, the Master-general, besides his veto, had a general authority; the Surveyor-general had control over the Artillery, Engineers, Sappers and Miners, Ordnance Medical Corps, contracts, laboratory, gunpowder, barracks, and navy gunners; the Clerk of the Ordnance managed the estimates, money-arrangements, civil establishment, pensions, superannuations, and ordnance property; while the principal Storekeeper had charge of stores, store-rooms, naval equipments, and naval war-stores. In matters relating to coast-defenses it was often difficult to decide between the Admiralty and the Ordnance, each Board claiming authority. When the Crimean disasters took place in 1854, the defects of the Board of Ordnance became fully apparent: it could not work harmoniously with the other Government Departments. The Board was dissolved, and the office of Master-general abolished. By the War Office Act of 1870 the post of Surveyor-general of the Ordnance was revived as one of the principal officers of the Secretary of State for War. He is responsible for the *matériel* and supplies of the army. See *Ordnance Board* and *Ordnance Corps*.

BOARD OF VISITORS.—A Board appointed by Act of Congress approved August 8, 1846, amended by Acts of March 16, 1868, and February 21, 1870, to attend the Annual Examination and make an annual report on the condition of the United States Military Academy. It consists of seven persons appointed by the President of the United States, two Senators appointed by the President of the Senate, and three Representatives appointed by the Speaker of the House of Representatives. An annual examination of the classes, preparatory to their advancement, shall commence on the first day of June (except when that day comes on Sunday or Monday, in which case it shall commence on the first Tuesday), at which time the Cadets shall be examined by the Academic Board, or its Committees, in all the branches of study and instruction through which they have passed in the previous academic year, in the presence of the Board of Visitors, or such members as may be present.

BOARDS OF SURVEY.—Boards of Survey have no power to *condemn* public property. They are called only for the purpose of establishing facts or opinions by which questions of administrative responsibility may be determined, and the adjustment of accounts facilitated; as, for example, to assess the amount and kind of damage or deficiency which public property may have sustained from any extraordinary cause, not ordinary wear, either in transit or in store, or in actual use, whether from accident, unusual wastage, or otherwise, and to set forth the circumstances and fix the responsibility of such damage, whether on the carrier, or the person accountable for the property or having it immediately in charge: to make inventories of property ordered to be abandoned, when the articles have not been enumerated in the orders; to assess the prices at which damaged clothing may be issued to troops, and the proportion in which supplies shall be issued in consequence of damage that renders them at the usual rate unequal to the allowance which the regulations contemplate; to verify the discrepancy between the invoices and the actual quantity or description of property transferred from one officer to another, and ascertain, as far as possible, where and how the discrepancy has occurred—whether in the hands of the carrier or the officer making the transfer; and to make inventories, and report on the condition of public property in the possession of officers at the time of their death. In no case, however, does the report of the Board supersede the depositions which the law requires with reference to deficiencies and damage.

It is required that Boards of Survey shall *fully investigate* the subject of losses submitted to them; that they shall call for all evidence attainable without limiting their inquiry to that submitted by the party or parties at interest; that they shall scrutinize rigidly the evidence, especially in the matter of property alleged to have been stolen or embezzled by deserters or others; and that they shall recommend no officer or soldier to be relieved from responsibility for property till the proof shall be clear and conclusive that he has given it his watchful attention, and fully performed his duty in regard to it. In order to relieve an officer from liability on account of public property which has become damaged, except by fair wear and tear, or which is believed to be unsuitable for the service, it shall, before being submitted to an Inspector for condemnation, be examined by a Board of Survey. Exceptions will be made in cases of animals or other public property infected with contagious disease, which may be summarily disposed of by order of a Commanding Officer. One copy of the proceedings of the Board will accompany the inventory and inspection report which is transmitted, as a voucher, with the accounts and returns of the officer responsible for the property. Another copy of the proceedings of the Board and of the inventory and inspection report will be filed with his retained papers.

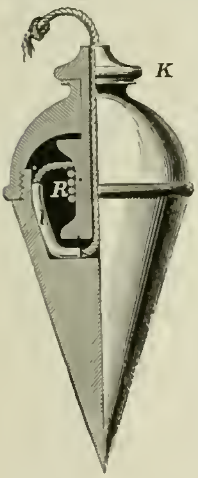
Boards of Survey are not convened by any other than the Commanding Officer present. They are composed of as many officers, not exceeding three, as may be present for duty, exclusive of the Commanding Officer, and the officer responsible in the matter to be reported on. In case the two latter only are present, then the one not responsible will perform the duties. When the responsible officer is the only officer at a post, he will, instead of constituting himself a Board, furnish his own certificate of the facts of the case, accompanied by affidavits of Non-commissioned Officers at the post cognizant thereof. If this should not be satisfactory, the Department Commander, upon notification, may send an Inspector to make the necessary report. Neither the Commander nor any member of the Board should be parties interested in the matter to be investigated. A Board of Survey has no legal power to swear either itself, its members, or witnesses before it.

BOAR'S HEAD ORDER OF BATTLE.—Among the orders of battles among the ancients, that known as the *wedge*, or *boar's head*, is the most celebrated. In this disposition, the *point*, or *head*, is formed of a subdivision of the phalanx of greater or less strength, according to circumstances; this being supported by two, three, and four subdivisions of the same force, one behind another. See *Order of Battle*.

BOAT.—A small open vessel used in military operations for crossing rivers, and for forming pontons, flying-bridges, etc. When the services of a bridge of boats is dispensed with, i.e., no longer required by the army, the boats should be broken up, to prevent their falling into the hands of the enemy.

BOAT-BRIDGE.—A boat-bridge consists of a track laid on a number of boats anchored parallel in the stream, or moored to ropes or chains which pass from bank to bank. The bridge thrown across the Hellespont by Xerxes when he invaded Greece, 480 B.C., had a length of 500 paces, and was supported on ships used as *pontons*. Suspension-cables of flax and biblos united the ships; transverse beams were laid on the cables; the beams supported planks and earth, and the army marched across, bag and baggage. Many years after, there appears to have been a more permanent construction of this nature in the same vicinity. At Abydos is the Zengma, a bridge of boats which could be unfixed at pleasure for the passage of vessels. Cyrus, according to Xenophon, crossed the Meander on a bridge supported by seven boats. Bridges of boats were in general use in the Middle Ages, and are still used on the Continent of Europe. One at Strasburg is 1300 feet long. Boat-bridges, in a military point of view, are classed as ponton-bridges, the pontons or bateaux and the road-bed being transported on wagons with inclined planes, and raised and lowered by means of machinery driven by water-wheels. See *Bridges*.

BOB.—A conoidally shaped piece of metal suspended by a cord attached to its upper end, and used for determining vertical or, in connection with a level or straight edge, horizontal lines. It is indispensable in engineering operations, sighting guns, and placing various surveying and astronomical instruments centrally over stations or points of departure. The drawing shows an adjustable plum-bob, having a concealed reel, *R*, around which the cord, *l*, is wound by turning the milled head, *K*, on top. The friction upon the reel within will hold the bob at any desired point of the line. See *Pendulum* and *Plummet*.



Adjustable Plumb-bob.

BOCCACCI.—A peculiar kind of fire-arm used by the Italians. It is enlarged towards the muzzle in the shape of a trumpet. This gun is principally used, at present, by the Calabrians.

BOCH MAGAZINE-GUN.—This gun belongs to that system in which a fixed chamber is closed by a bolt by direct action, and in which the lock is concealed. The stock is in a single piece, extending nearly to the end of the barrel, and secured to it by bands held in place by springs. The tang-screw and the screw which passes into the receiver secure the latter to the stock. The trigger-guard is fastened by screws. The receiver has two longitudinal holes, one on each side. The opening on the left side is for the ejection of empty shells, and the one on the right side is for the introduction of cartridges, whether used as a magazine-gun or as a single-loader. The latter opening has at its ends two projections, which fit to corresponding surfaces on the magazine when the latter is attached. The receiver is perforated at its rear for the reception of the breech-bolt. The latter consists of three parts, viz., the rear piece through which the firing-pin passes, the projection of the pin fitting into a cut; the locking-tube, including the handle; and the bolt-head or body, through which the firing-pin passes, and which supports the cartridge at the instant of fire.

The firing-pin having been introduced into the rear piece is then passed through the firing-pin spring; the movable shoulder is then, by sufficiently compressing the spring, introduced over the head of the pin, and by giving it a quarter turn is retained on the pin bearing against the shoulders of the latter. The spring is then held compressed between the ends of the rear piece and the movable shoulder. The firing-pin and spring are passed through the locking-tube, and then through the bolt-head, which is screwed to the rear piece. The locking-tube has two projections which, when the handle of the bolt is turned down in the receiver, fit into two recesses in the latter, and the bolt is thereby held in position. When the handle of the bolt is turned up from the locked position, the curved surface of a cut cams back the firing-pin by means of a projection (which slides in the cut), and the latter then rests in a notch and the piece is cocked. When the handle is turned down the cut is brought opposite to the projection which, released from the notch, is held by the nose of the sear; hence the firing-pin cannot reach the cartridge until the bolt-handle is turned down, and accidental explosions are therefore avoided. The bolt-head carries the extractor, which is fastened to it by means of a dovetail-tenon which fits into a recess in the bolt-head. The bolt-head is prevented from turning by a projection fitting into a groove in the receiver. The sear is notched for the nose of the trigger. The sear-spring is attached to the under side of the tang by a screw. The trigger when pulled releases the projection of the firing-pin, and the cartridge is exploded. The extractor hooks on the rim of the cartridge when the bolt is closed, and, when it is withdrawn, throws out the empty shell through the hole in the left side of the receiver by deflecting it from the axis of the chamber. The magazine is attached to the right side of the receiver, and is operated by a wheel which, when a cartridge is to be introduced, is turned so that a cartridge can drop into the receiver, when the bolt pushes it well into the chamber. The magazine holds twenty cartridges.

In another pattern of the Boch gun the stock is in two parts, the butt and the tip; these are joined together and to the barrel by a band which passes around the ends of the two parts, at their junction, and the barrel. Another band fastens the front end of the tip-stock to the barrel. In the right side of the butt-stock is a longitudinal opening coincident with a similar one in the receiver. Through this hole cartridges may be introduced on the carrier. The butt-stock is grooved to fit the barrel and cut through for the receiver, which is fastened to the stock by means of a tang-screw, passing through the stock into the trigger-guard plate. The butt-stock is also perforated by a hole continuous with one in the tip-stock, through which the magazine-tube passes, the latter being fastened to the receiver by a screw-thread. This gun carries nine cartridges in the magazine and one in the chamber. As a magazine-gun, three motions are necessary to operate it, viz., opened, closed, fired; as a single-loader, four motions, viz., opened, loaded, closed, fired. See *Magazine-gun*.

BODKIN.—Anciently a dagger. The bodkin was used by women of antiquity to fasten up their hair behind. It was the method commonly adopted by the priests of Cybele, as well as by the female characters in Greek tragedy, the bodkin being highly ornamented. Silver bodkins are still worn in a similar way by the peasant-girls of Naples. The term bodkin is also applied to a sharp-pointed instrument for piercing holes in cloth, and it was at one time a very common name for a dagger.

BODY.—1. In the nomenclature of modern ordnance, the part of the piece in rear of the trunnions. 2. In the Art of War, a number of forces, horse or foot, united and marching under one commander. 3. That portion of a carriage, including framing and boarding, which forms the receptacle for conveyance of stores. The frame of the body generally consists of two frame sides, a front and hind ear-bed, and two or more summers. 4. That portion of the axletree between the axletree-arms.

BODY-GUARD.—A guard designed to protect or defend the person; a life-guard.

BODY OF THE PLACE.—The enceinte of a fortress, or main line of bastions and curtains, as distinguished from outworks.

BŒOTIAN HELM.—An ancient and favorite head-covering. It was made deep, with neck and cheek-guards, the whole being wrought into a solid mass, which would cover and effectually protect the wearer from the shoulders upwards.

BOGHEAD COAL.—Bituminous coal of Scotland, more valuable for making gas than for fuel. Named from the chief place of deposit, Boghead, Linlithgowshire.

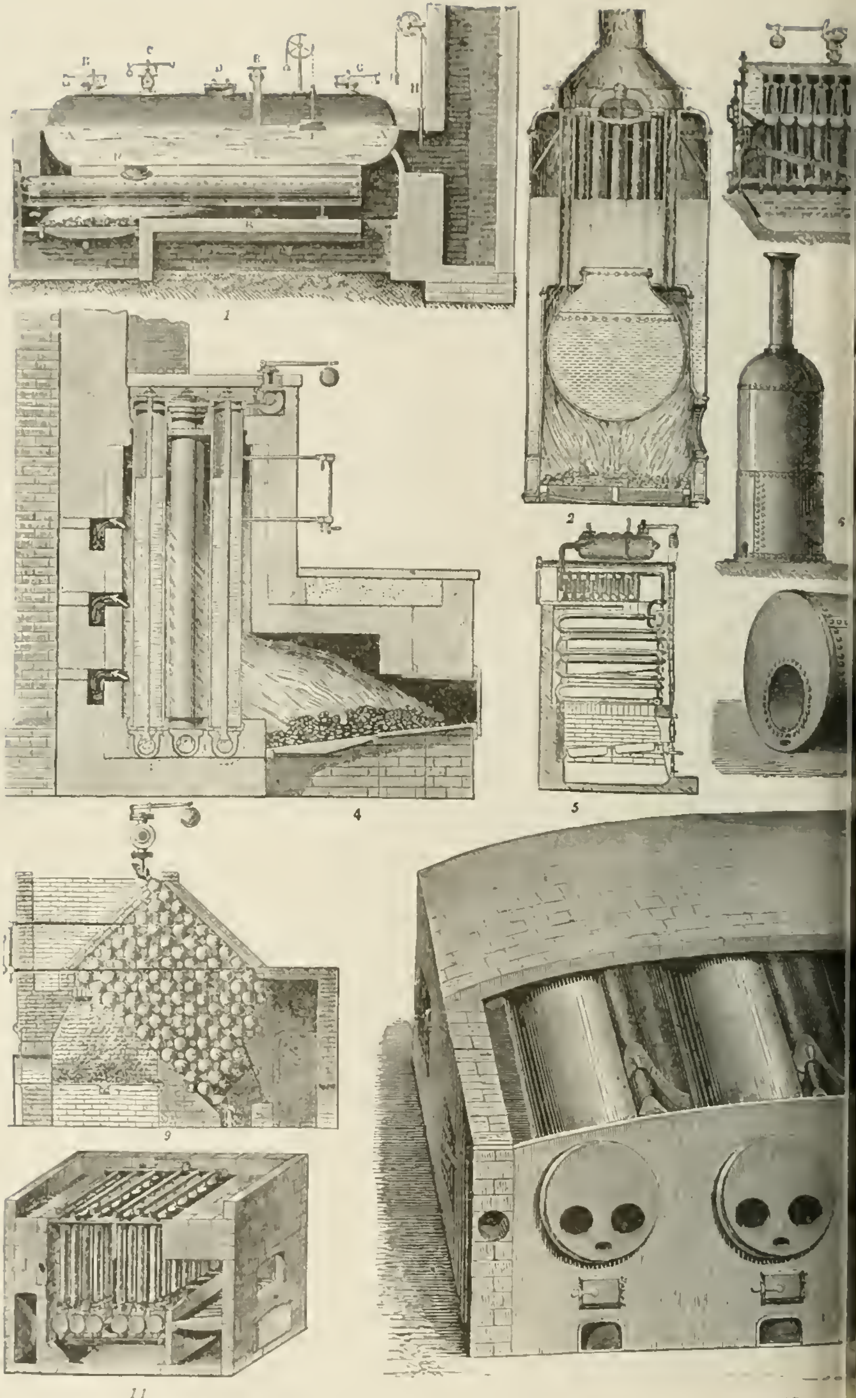
BOG IRON-ORE.—A mineral of very variable composition, but regarded as consisting essentially of peroxide of iron and water; the peroxide of iron often amounts to about 60 per cent, the water to about 20. Phosphoric acid is usually present in quantities varying from 2 to 11 per cent. Silicic acid, alumina, oxide of manganese, and other substances, which seem accidentally present, make up the rest. Bog iron-ore occurs chiefly in alluvial soils, in bogs, meadows, lakes, etc. It is of a brown, yellowish-brown, or blackish-brown color. Some of its varieties are earthy and friable, formed of dull dusty particles; some are in masses of an earthy fracture, often vesicular; and some more compact, with conchoidal fracture. It is abundant in some of the northern and western islands of Scotland, and in the northern countries of Europe generally; also in North America. When smelted it yields good iron. From what source the iron in bog iron-ore is derived has often been a subject of discussion; but Ehrenberg appears to have determined that it proceeds from the shields of animalcules, and he regards the mineral itself as composed of incalculable multitudes of these shields. He found in the marshes about Berlin a substance of a deep ochre-yellow passing into red, which covered the bottom of the ditches, and which, when it had become dry after the evaporation of the water, appeared exactly like oxide of iron; but which under the microscope was found to consist of slender articulated threads, formed of the partly silicious and partly ferruginous shields of *Gaillonella ferruginea*.

BOG-SPAVIN.—This singular name has been applied to a lesion of the hock-joint of the horse, consisting in distension of the capsule inclosing the joint. It usually arises suddenly from a sprain in action. It most commonly affects young horses with defective hocks, and is associated with other indications of weakness of the injured joint.

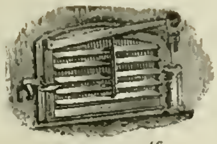
Symptoms.—As the immediate result of a violent sprain, the hock becomes swollen, hot, and tender, and there is considerable lameness. The acute symptoms subside readily, but a circumscribed swelling remains towards the front, inner, and lower part of the joint. The swelling is soft, partly disappears on pressure if the joint is moved; but on the horse standing firmly on its limbs, the projection is distinctly visible. At every recurring strain lameness supervenes, but commonly passes off within a short time. If the bog-spavin has accidentally occurred in a young horse with good hocks, it may never be attended with inconvenience, and the acute symptoms mentioned do not relapse.

Treatment.—The treatment of bog-spavin consists in the application of stimulating embrocations, or mild blisters, in the early stage; in severe cases the golden ointment of iodine is the best application; but we can only obtain a reduction in the inflammatory symptoms, and disappearance of the lameness. The capsular ligament which is injured is never again completely restored, and the horse is more or less blemished for life. See *Veterinary Art*.

BOILER.—The name given to a vessel in which steam, usually for a steam-engine, is generated. In its simplest form it consists of a close vessel made of metal plate, having apertures for the admission of water and egress of steam, fitted with apparatus for showing the level of the water and the pressure of the steam, and in connection with a furnace, either internal or external. When water is boiled in an open pan, the temperature of the water and of the steam rising from it remains at or very near 212 F., and the tension or pressure of the steam is no more than sufficient to make its way into the atmosphere, being exactly equal to that exerted in all directions by the atmosphere itself—namely, 14.7 lbs. per square inch. In a close vessel, on the other hand, the temperature and pressure to which we can raise the steam are only limited by the strength of the vessel or boiler against bursting. The form of a boiler is determined by two considerations—namely, strength to withstand internal pressure, and efficiency in producing steam; and the object of the designer is to combine in one apparatus sufficient strength to work safely at the proposed pressure, with such a form and arrangement as shall abstract the maximum of heat from the gases of combustion, and at the same time be in all respects suitable to the special circumstances of the case. The globular form is that best adapted for strength, and was the earliest to be used. It presents to the fire, however, the minimum area in proportion to its contents, and therefore has a minimum efficiency. After spherical boilders, cylindrical ones came into use, at first set on end, and afterwards laid on their sides, and later on these were furnished with internal cylindrical tubes for furnaces. Watt's "wagon-boiler" (so called from its shape) was used for many years, but, being quite unfit for any but the lowest pressures, it has long been discarded; and the "egg-end" boiler, or plain cylinder with hemispherical ends, also much used at one time, has now almost disappeared on account of its small evaporative efficiency. At present it is quite common to use a working steam-pressure of 50 lbs. per square inch in ordinary factory boilers, and in some cases this is already greatly exceeded, while the tendency to use higher pressures seems to grow yearly. Under these pressures, the only forms of boiler which can be used without heavy and expensive internal stays to prevent the danger of bursting are the globular and the cylindrical. The former shape is rejected for the reason already given, and the latter form is used almost invariably in the construction of modern boilers, as will be seen from the examples given below. The ends of the cylinders, when it is necessary to make them flat, must, of course, be strengthened by stays. Boilers may be classified in several ways—as (1) horizontal and vertical; (2) internally and externally fired; and (3) plain multitubular, and tubulous. Large boilers are almost invariably horizontal, but small vertical boilers are often used. They are employed in steam-cranes and other situations where great length would be an inconvenience, and often in traction-engines, where steep inclines have to be traversed, and where, if a locomotive-boiler were used, one or the other end of its tubes might become uncovered and so get burned. In Great Britain, when moderately good fuel is used, boilers with an internal furnace are generally preferred; but in America the common brown coal is much inferior to English fuel, and a correspondingly larger quantity of it must be used to generate a given volume of steam. As the size of a furnace limits the fuel which it can burn, this fre-



BOILERS. 1. Common steam boiler and fire-box. 2. Thomson's vertical tubular boiler. 3. Mille
7. Common horizontal tubular boiler. 8. Common Cornwall boiler. 9. Harrison's steam
tubular boiler. 12. Clark's compound steam-boiler. 13. Field's steam-boiler. 14 Section
smoke-consuming apparatus and chain-heater. 19. George's screw-heater and smoke-cons



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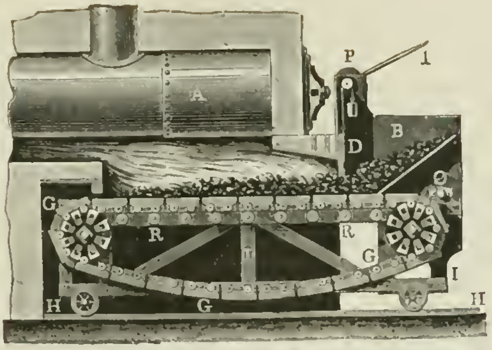

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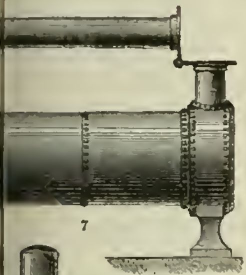

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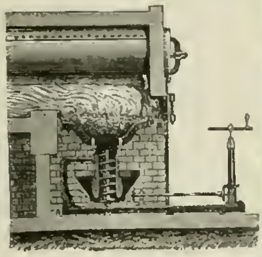

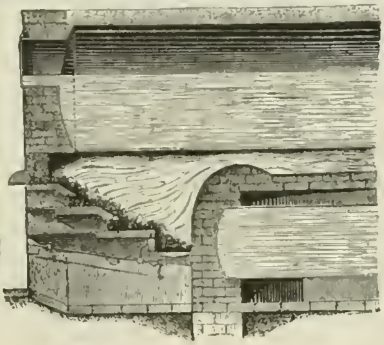

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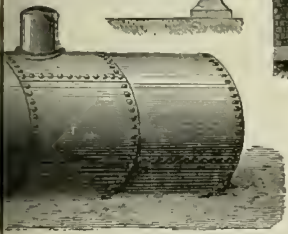

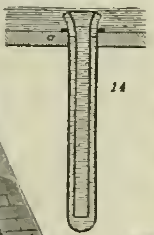

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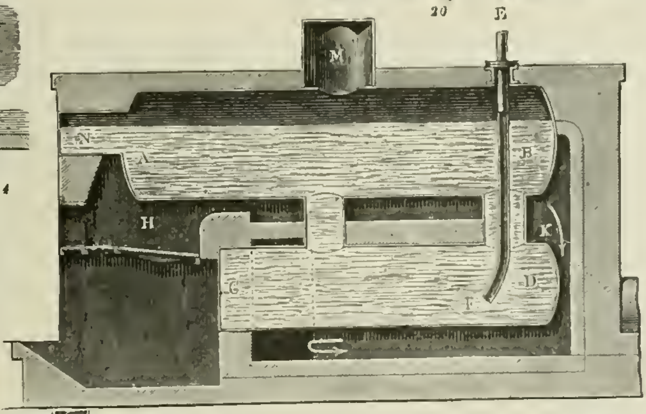

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ar boiler. 4. Jordan's tubular boiler. 5. Belleville's tubular boiler. 6. Common vertical tubular boiler.
of cast-iron spherical shells). 10. Common steam-boiler with outer fire-box. 11. Howard's cast-iron
ubes. 15. Bell's cast-iron tubular boiler. 16. 17. Prideaux's smoke-consumer or fire-door. 18. Jukes'
's smoke-consumer and sectional-heater.

quently involves having a much larger grate than could be conveniently arranged inside the boiler, and on this and other accounts boilers are more frequently externally fired. See *Furnace*.

BOILING-POINT.—When heat is applied to a vessel containing water, the temperature gradually rises, and vapor comes silently off the surface; but at a certain degree of heat steam begins to be formed in small explosive bursts at the bottom, and rising through the liquid in considerable bubbles, throws it into commotion. If, after this, the steam is allowed freely to escape, the temperature of the water rises no higher, however great the heat of the fire. The water is then said to *boil*, and the temperature at which it remains permanent is its *boiling-point*. The boiling-point of water is ordinarily 212°; but every liquid has a point of its own. Thus, sulphuric ether boils at 96°; alcohol, at 176°; oil of turpentine, at 316°; sulphuric acid, at 620°; and mercury, at 662°. The boiling-point of liquids is constant under the same conditions, but is liable to be altered by various circumstances. For example, water with common salt in it requires greater heat to make it boil than pure water. The nature of the vessel, too, exerts an influence; in a glass vessel the boiling-point of water is a degree or two higher than in one of metal, owing to the greater attraction between water and glass than between water and a metal. But what most affects the boiling-point is variation of pressure. It is only when the barometer stands at 30 inches, showing an atmospheric pressure of 15 lbs. on the square inch, that the boiling-point of water is 212°. When the barometer falls, or when part of the pressure is in any other way removed, it boils before coming to 212°, and when the pressure is increased the boiling-point rises. Thus, in elevated positions, where there is less air above the liquid to press on its surface, the boiling-point is lower than at the level of the sea. An elevation of 510 feet above the sea-level makes a diminution of a degree; at higher levels, the difference of elevation corresponding to a degree of temperature in the boiling-point increases; but the rate of variation once ascertained, a method is thus furnished of measuring the heights of mountains. At the city of Mexico, 7000 feet above the sea, water boils at 200°; at Quito, 9000 feet, at 194°; and on Donkia Mountain, in the Himalayas, at the height of 18,000 feet, Dr. Hooker found it to boil at 180°. Boiling water is thus not always equally hot, and in elevated places many substances cannot be cooked by boiling. Under the receiver of an air-pump the same effect is still more strikingly seen; water may be made to boil at the temperature of summer, and ether when colder than ice. In complete vacuo, liquids, in general, boil at a temperature 140° lower than in the open air. The knowledge of this effect of diminished pressure is now largely turned to account in sugar-boiling, in distilling vegetable essences, and in other processes where the substances are apt to be injured by a high temperature.

BOLA.—A long strong cord, or small rope, having a stone or a ball of metal fixed at one end; or, sometimes, it consists of two such cords, each provided with a stone or ball. The cords being secured by their other ends to the person, he whirls the two balls rapidly, and with great adroitness, about his head, and then discharging them at the object, strikes it as with a blow from a flexible club. Such a blow takes effect with great violence. The management of the bola requires long practice and no ordinary skill.

BOLADE.—An ancient weapon of the shape of a mace. Now little used.

BOLAND KNAPSACK.—This knapsack is made up as follows: The body is made of water-proof material, 14½ inches square by 4 inches deep for the largest-sized men. The sides are made of sole-leather and have the necessary stiffness. Stay-straps pass entirely around the knapsack-box proper, and side-straps are provided to secure the blanket when rolled. The shoulder-straps are secured by buckle on one, and hook and loops on the other. The blanket is carried rolled, and secured to three sides of the knapsack; overcoat on top.

The advantages claimed for this knapsack are that the weight carried is more equally distributed; that it is kept close to and inside the line of gravity of the carrier, and is well up and retained close to the shoulders. The knapsacks are made of four sizes for different-sized clothing.

BOLAS.—A form of missile used by the Paraguay Indians, the Patagonians, and the Esquimaux. The Patagonians have several varieties. That used in war consists of a single ball of hardened clay or rounded stone, weighing about a pound, and fastened to a stout rope of sinew or skin. This they sometimes throw at their adversary, rope and all, but generally they prefer to strike his head with it, like a slung-shot. That used by the hunters in capturing wild cattle consists of two leather balls, covered and united by a narrow but stout thong. The cattle-hunter holding one ball swings the other around his head until proper momentum is gained, and then launches the bolas at the legs of the animal, which it instantly ties together, rendering him helpless. It is said that the natives can use the bolas effectually at 80 yards. The bolas of the Esquimaux consists of a number of walrus-teeth attached to the ends of strings whose other ends are united into a knot.

BOLLARS.—Large posts driven into the ground to which hawsers or cables of any sort can be made fast. They are recommended to be provided at the tops of ramps, or in narrow passages, and in masonry-works.

BOLSTERS.—Strong stout bars or beams fastened across the under portion of the frame of a wagon-body, or across the futchells of the fore-carriage. Their functions are various; sometimes they are added to give strength and rigidity to the structure, sometimes to raise its height above the axletree, and sometimes to form a convenient attachment for springs or other necessary iron-work. The term *bolster* is also applied as follows: The lower part of the cheek of a gun-carriage. The iron collar in which a gun turns in the boring-bench. The quoin or wooden bolster by which a mortar is raised in its bed.

BOLT.—1. A pointed shaft or missile intended to be shot from a cross-bow or catapult. 2. An elongated solid projectile for rifled cannon, as the Whitworth and Armstrong guns. See *Bolts*.

BOLT-CUTTERS.—In these most valuable machines for the arsenal, the bolts are generally cut as with solid dies, at one operation, the dies opening under cut when the work is done, and in releasing the bolt remove all trace of the chip made by the cutting-tools. On the back of the large driving-wheel (Fig. 1), is an index or pointer, which must be set to numbers given on a card furnished with each machine. When so set, the bolt will fit a nut of corresponding size cut with the tap sent with machine. An adjustment of the index, one way or the other, will cause the bolt cut to be larger or smaller, thus permitting the thread to be adapted to the use required of it, and also permitting an adjustment of dies to compensate for wear. Some important improvements have recently been made in this machine, viz.: A change in the mode of driving renders it possible to run them at a higher speed, and a novel oil-feeding device supplies the oil to the back of the dies, whence flowing out it thoroughly lubricates the cutters and the bolt-end, and washes out the chips as they are cut from the bolt. A regulating cock in the feed-pipe directs the oil either to the dies as above stated, or to the tap when the machine is used as a nut-tapper. The machines are constructed with four dies in the die-box. These dies are equally spaced, and each pair has one die diametrically opposite to the other one of the pair. This arrangement insures accurate work, inasmuch as the opposite dies calliper the bolt while being cut, thus making the bolt round and to gauge. Added to this a convenient adjustable stop-motion is provided whereby the dies are opened automatically when a given length of thread has been cut. These improvements have added greatly to the value of this important tool, which is made and used extensively in England and on the Continent, and is believed to have no equal in durability and

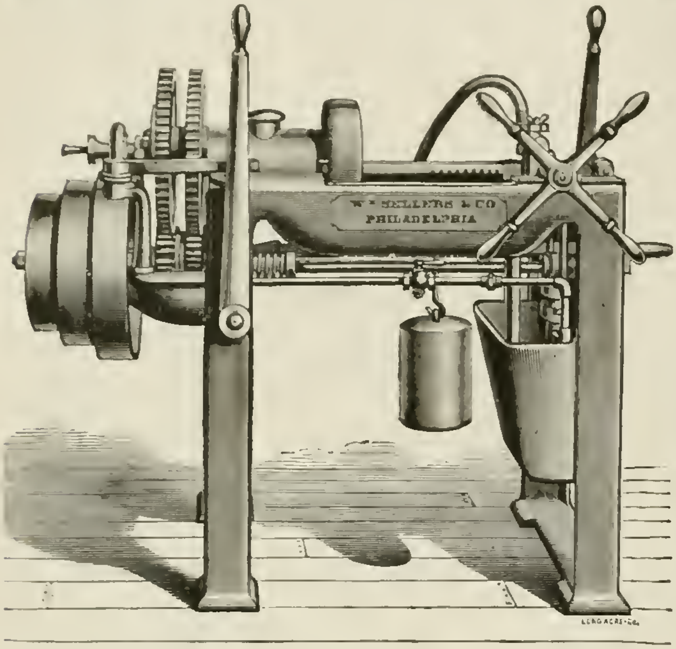


Fig. 1.

efficiency. The counter-shafts are made with two loose pulleys, one on each side of a fast one, so that open and cross belts can be used to run the machine backwards as well as forwards. This running backwards is only of use in recutting dies or cutting left-handed screws. To sharpen the dies, they must be softened, and then recut with hobs which are specially made for this purpose. The hobs are guided in recutting dies by collars fitting in a hollow sleeve, which guide a prolongation of one end of the hob, while the other end is steadied in the clamp for holding the bolts to be cut. This insures perfect concentricity to the dies. It must be borne in mind that in the use of bolt-cutters oil should be freely used upon the work. This on the new-style machine is accomplished by the automatic feed; and the oil used should be *animal*, not from *coal*. The commonest lard or fish oil will answer a good purpose. Fig. 1 represents the Sellers ¾-inch size of machine intended to cut from ¼ to ¾ inch. This size is admirably adapted to cut set-screws and small bolts. In using it with set-screws it is well to arrange a socket-wrench to be clamped in the bolt-holder, the head of the set-screw fitting the socket loosely. By the use of such a device the bolts can be set and removed more rapidly than when each one has to be clamped in the bolt-holder. This machine has been run at the rate of 2800 bolts in ten hours on ⅜-inch bolts threaded two inches in length, but this rate is not economical, inasmuch as the excessive speed is too hard on the dies. The counter-shaft should be speeded to 200 revolutions per minute; the speed on the dies of the fastest and the slowest speeds will then be at the rate of 12 feet circumferential motion per minute on ¾-inch and on ⅜-inch bolts. The ¾-inch bolt, having ten threads per inch, will be threaded at the rate of six inches in length of bolt per minute, and if the thread be 1½ inches long, at the rate of four per minute, exclusive of the time consumed in putting in and taking out the bolts; one man can at this rate very well run two machines cutting from 1500 to 1800 ¾-inch bolts on each machine.

The Babbitt bolt-cutter will cut screw-threads in nuts and on bolts by once passing over them, cutting the standard number of threads to the inch on all the sizes, and making as great uniformity in the fits between the nuts and bolts as can be desired. The great advantage of this machine consists in the facility and ease in changing dies. No backing off is required. This saves nearly one half the time required to do the work over the solid die. There is no danger of tearing off the thread or injuring the die in breaking off. A solid die soon wears a little, and the tap the same. The result is that the bolt will not enter the nut without a wrench, if at all, and a new tap or die has to be made. This machine, if properly adjusted, will cut a complete thread, and reduce the bolt to suit the tap, however much it may be worn. It is much praised for its practical efficiency and economy in running, as well as adaptation to all kinds of work in the armory. The counter-shaft has pulleys fourteen inches diameter and four inches face. Should run one hundred and fifty revolutions.

The open-die machine made by the Pratt and Whitney Company is a very superior one. Instant release of the bolt when threaded, without running back through the dies, is a peculiarity of this machine. The die-head is constructed to receive finished blocks or cases, with inserted chasers, forming the dies, thus doing away with the labor of fitting each die or chaser to the head. The chasers, four in number, in simpler form, are planed or fitted to cases with a file, from pieces of flat steel, averaging 1¼ inches in length and $\frac{5}{16}$ inch in thickness, threaded in the machine by hobs or master-taps and set forward by a screw in the end of each case for dressing when the thread is worn out. Broken or damaged chasers can be replaced by duplicates at little expense. The adjustment of dies to the proper diameter is accomplished by

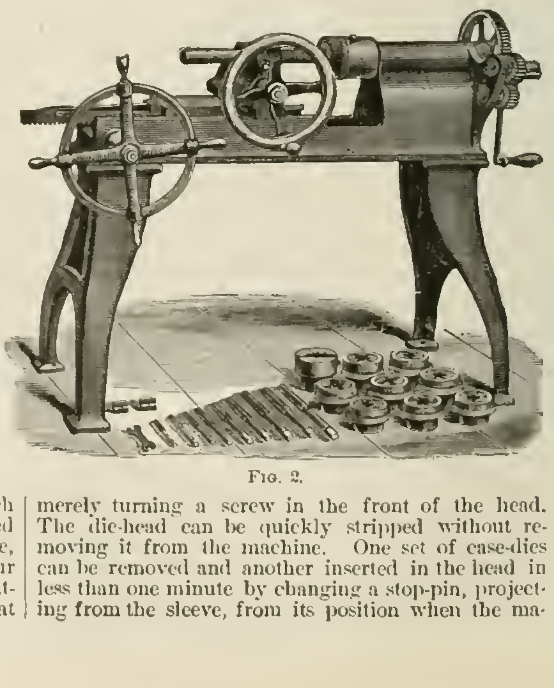
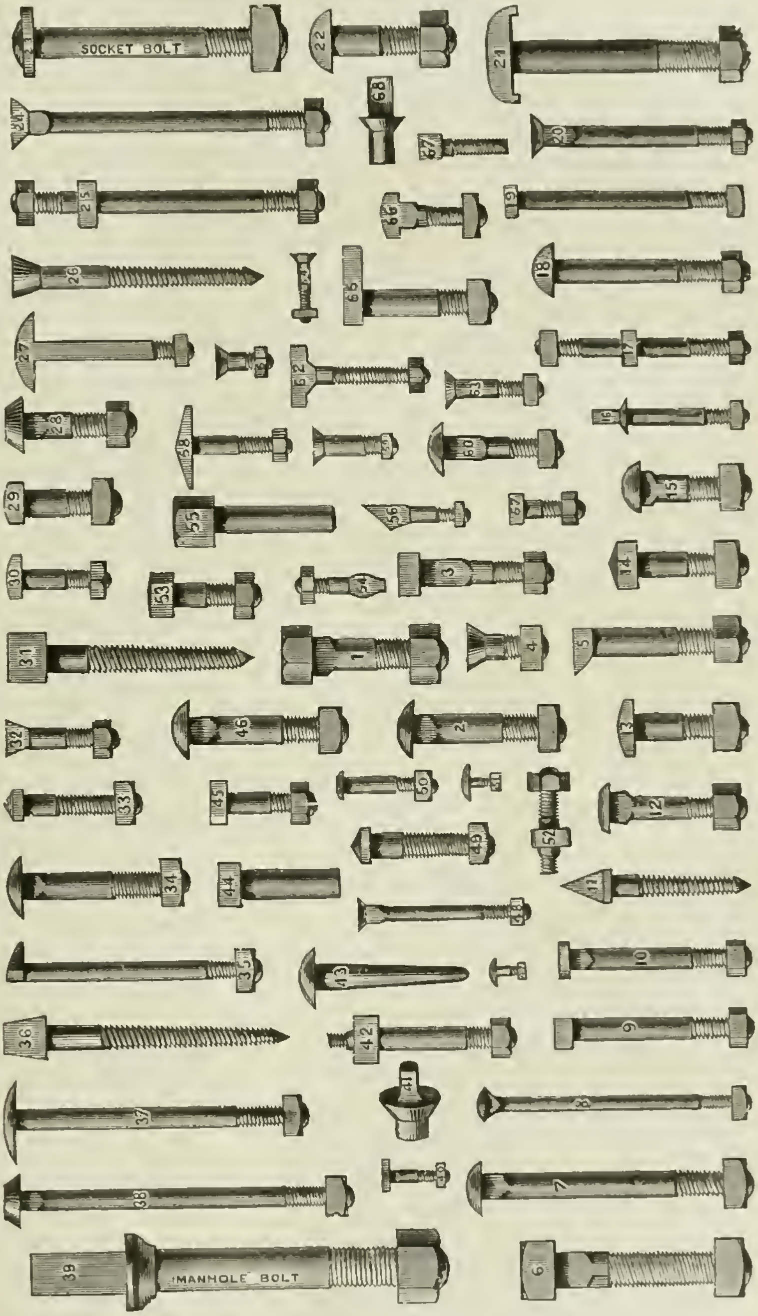


Fig. 2.

merely turning a screw in the front of the head. The die-head can be quickly stripped without removing it from the machine. One set of case-dies can be removed and another inserted in the head in less than one minute by changing a stop-pin, projecting from the sleeve, from its position when the machine is working, to a point opposite a hole in the flange at the rear of the head, then, by means of the lever, pushing the sleeve back to the flange, uncovering the cases, and permitting their removal and replacement by hand. The machine can be quickly converted into a nut-tapper, by removing the case-dies and putting in their place a steel block to which is secured a universal chuck for holding taps that is furnished with each single-head machine only. The locking device is positive and requires but one movement of the lever, by hand or automatically, for unlocking and opening the dies, when the desired length of thread has been cut, or closing and locking. The hollow spindle allows a piece to be threaded any length desired. The machines work rapidly, the bolt being cut to a full thread at one operation. The die-blocks are held rigidly by the inclosing sleeve when locked, and consequently cut bolts of more uniform diameter than is the case when the chasers or cutters can spring away from the bolt when cutting. The arrangement and operation of the stop-pin is such that a longer thread cannot be cut on a bolt than is permitted by the adjustment of the automatic opening apparatus when the latter is employed.

Fig. 2 shows a small hand bolt-cutter adapted for light work on gun-carriages, etc. It is mounted on legs, and is suitable for cutting ½-inch to 1½-inch bolts and ¼- to 2-inch pipe. The crank and socket are used on the stud of a small gear to cut ⅞ and larger bolts, and upon the spindle of the machine to cut ¾-inch and smaller bolts, and to back the die quickly off from large bolts after cutting, the spindle and the die revolving in the direction that the crank is turned. Threads may be cut a length of eighteen inches as the machine is usually constructed. Nine taps and dies are furnished with the machine to cut threads of the following sizes: ½, 13; ⅝, 11; ¾, 10; ⅞, 9; 1, 8; 1⅛, 7; 1¼, 7; 1⅜, 6; 1½, 6. Weight of machine, with tap-chuck, nine dies and taps, about 350 pounds.

BOLTS.—Stout metal pins, variously employed in ordnance and artillery constructions for holding objects or parts together, and frequently screw-threaded at one end to receive a nut. Bolts for permanently fastening objects may be distinguished, first, by their construction; secondly, by their application. As to construction, the difference may regard the head; as, round, square, hexagon, octagon, saucered, countersunk-headed, clinch, collared, chamfered, diamond, convex, etc.: some structural peculiarity of the head; as, eye, doubled-headed, hook, ring, T-headed, etc.: the mode of securing; as, screw, fox, forelock, clinch, rivet, rag, bay, barb, jag, key. As to the nature and purpose of their application they may be,—assembling, fish, foundation, bringing-to, carriage, drive, fender, lewis, set, shackle, wagon-skein, tire, king, scarf, through, etc. The following list of bolts, manufactured by Messrs. Hoopes & Townsend of Philadelphia, and exhibited at the Centennial in 1876, is approximately complete:



Bolts used in Arsenals and Armories.

Assembling-bolt,
Barbed bolt,
Bay-bolt,
Bringing-to bolt,
Carriage-bolt,
Clinch-bolt,
Countersunk-headed bolt,
Diamond-headed bolt,
Door-bolt,
Drive-bolt,
Eye-bolt,
Fender-bolt,
Fish-bolt,
Flour-bolt,

Flush-bolt,
Forelock-bolt,
Foundation-bolt,
Fox-bolt,
Half-turning bolt,
Holding-down bolt,
Hook-bolt,
Jagged bolt,
Key-bolt,
Lewis-bolt,
Manhole-bolt,
Pointed bolt,
Rag-bolt,
Ring-bolt,
Riveted bolt,
Rose-headed bolt,
Round-headed bolt,
Scarf-bolt,
Screw-bolt,
Set-bolt,
Shackle-bolt,
Shingle-bolt,
Socket-bolt,
Square-headed bolt,
Tire-bolt,
Wagon-skein bolt.

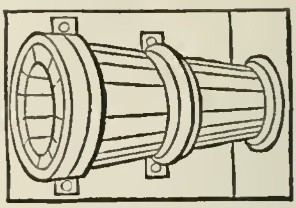
The important bolts fabricated and used in arsenals and armories are shown in the drawing on the preceding page. The following table gives the weight of bolts, of given diameter and length, per hundred:

Diam	1/4	5/16	3/8	7/16	1/2	9/16	5/8	3/4	7/8	1
Lgth.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.
1½	4	7	10.50	15.20	22.50	30	39.50			
1¾	4.35	7.50	11.25	16.30	23.82	31.75	41.62			
2	4.75	8	12	17.40	25.15	33.50	43.75	69	108	
2¼	5.15	8.50	12.75	18.50	26.47	35.25	45.88	72	112.25	
2½	5.50	9	13.50	19.60	27.80	37	48	75	116.50	175
2¾	5.75	9.50	14.25	20.70	29.12	38.75	50.12	78	121.75	180
3	6.25	10	15	21.80	30.45	40.50	52.25	81	126	185
3½	7	11	16.50	24	33.10	41	56.50	87	134.25	196
4	7.75	12	18	26.20	35.75	47.50	60.75	93.10	142.50	207
4½	8.50	13	19.50	28.40	38.40	51	65	99 05	151	218
5	9.25	14	21	30.60	41.05	54.50	69.25	105.20	159.55	229
5½	10	15	22.50	32.80	43.70	58	73.50	111.25	168	240
6	10.75	16	24	35	46.35	61.50	77.75	117.30	176.60	251
6½	11.50	17	25.50	37.20	49	65	82	123.35	185	262
7	12.25	18	27	39.40	51.65	68.50	86.25	129.40	193.65	273
7½	13	19.25	28.50	41.60	51.30	72	90.50	135	202	284
8	13.75	20.75	30	43.80	59.60	75.50	94.75	141.50	210.70	295
9			34	48.20	64.90	82.50	103.25	153.60	227.75	317
10			37.50	52.60	70.20	89.50	111.75	165.70	244.80	339
11			41	57	75.50	96.50	120.25	177.80	261.85	360
12			44.50	61.40	80.80	103.50	128.75	189.90	278.90	382
13					86.10	110.50	137.25	202.	295.95	401
14					91.40	117.50	145.75	214.10	313	426
15					96.70	124.50	154.25	226.20	330.05	448
16					102	131.50	162.75	238.30	347.10	470
17					107.30	138.50	171	250.40	364.15	492
18					112.60	145.50	179.50	262.60	381.20	514
19					117.90	152.50	188	274.70	398.25	536
20					123.20	159.50	196.50	286.80	415.30	558

The following general rule is given for the computation of the weight of wrought-iron bolts: Square the radius of the bolt, and multiply it by ten; the product will give the weight in pounds per foot. For cast-iron bolts, multiply the above result by .074.

BOMB.—A missile which also receives the names of *bomb-shell* and *shell*. It is a hollow ball, usually of cast-iron, fired from a mortar or other large piece of ordnance, and filled with combustibles which work great havoc when the ball bursts by the firing. All such projectiles were formerly fired from mortars only, and there was thus a definite relation between the bomb and the mortar; but since the invention of shell-guns and other modern pieces of artillery, the name *shell* has been generally substituted for that of *bomb*. The 13-inch bomb, which is the largest size used in ordinary warfare, weighs about 195 lbs., with a thickness of metal varying from 1½ to 2 inches at different parts; it bursts with about 8 lbs. of powder. The vent through which it is filled with powder is, after the filling, closed with a plug called a *fuse*, which sets fire to the powder, and at the proper moment bursts the bomb into fragments. The 10-inch bomb, weighing about 90 lbs., is proportionably less in all dimensions than that just described; and so on for those of smaller diameters. It should be understood, however, that the above are conventional quantities prescribed and adopted more than half a century ago. Modern artillerists try experiments on bombs of various degrees of thickness with various charges and fuses. See *Shell*.

BOMBARD.—An ancient piece of ordnance, which was very short, thick, and wide in the bore. It differed from the balista in being worked with gunpowder instead of by mechanical force, and from the mortar in shooting forth stones instead of iron shells. Some of the bombards used in the fifteenth century propelled stones weighing from 200 to 500 lbs. each. The shape of the first cannon used after the invention of gunpowder was conical, internally and externally resembling an apothecary's mortar. They were called *mortars*, *bombards*, and *vases;* were tired at high angles; and, in consequence of the slow burning of the powder of that day and the conical shape of the bore, the stone balls projected by them proceeded with very little velocity and accuracy. Bombards were made first of wood banded with wrought-iron, then of sheet-iron strengthened by hoops and brazing, and later of longitudinal iron bars, connected and hooped like the staves of a cask. As none of these constructions gave the requisite strength, cannon were subsequently made of wrought-iron, then of cast-iron, and finally of bronze.



BOMBARDELLE.—A small bombard which was used in ancient times. In 1830 one was disinterred near Laon, France; it is the opinion of some that this bombardelle was manufactured during the reign of Charles VII., from 1436 to 1440.

BOMBARDIER.—An artilleryman versed in that department of arms which relates especially to bombs and shells, mortars and howitzers, grenades and fuses. He has learned to load shells and grenades, fix fuses, prepare composition for fuses and tubes, etc.; and on the field or at sieges he fires the mortars. In some foreign armies the bombardiers form a separate corps; but usually there are some attached to every battery.

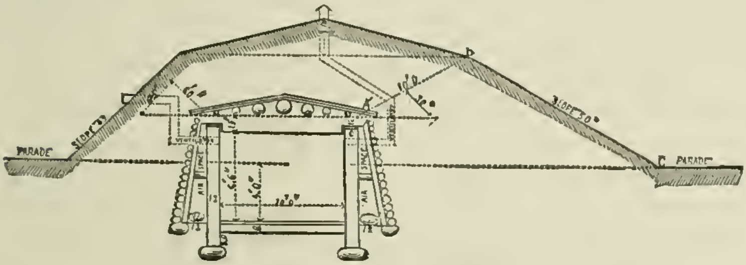
BOMBARDMENT.—An attack upon a fortress or fortified town by means of shells, red-hot shot, carcasses, rockets, etc., to burn and destroy the buildings and kill the people. A bombardment is most likely to be successful when the place is destitute of bomb-proof cover; or when the Governor is too humane to expose the unoffending inhabitants to this dreadful ordeal; or when the population is strong enough to compel him to yield. A bombardment requires little engineering science; whereas to reduce a place by regular siege requires the aid of engineers to direct the attack against fortifications, guns, and soldiery, leaving the inhabitants and buildings untouched. Military engineers generally regard a bombardment as a cruel operation; it is especially directed against the civilians and their buildings, as a means of inducing or compelling the Governor to surrender the place and terminate their miseries. In a well-defended place, the soldiers, the ammunition, and the defense-works suffer comparatively little, seeing that the bombardiers aim at pitching their terrible missiles into the heart of the place. In modern times a bombardment is mostly adopted as an adjunct to a siege, distracting the Governor by an incessant fire of mortars day and night. At Sebastopol, for instance, the mortars fired shells into the center of the city, to weaken the defense of the forts which were cannonaded by the siege-guns. Bombardment is more frequently a naval than a military operation. The stores required for a vigorous bombardment are immense. Thus, in 1759 Rodney threw 20,000 shells and carcasses into Havre; in 1792 the Duke of Saxe-Teschen threw 36,000 shot and shell into Lille in 140 hours; in 1795 Pichegru threw 8000 shells into Mannheim in 16 hours; and in 1807 the English threw 11,000 shot and shell into Copenhagen in three days.

BOMB-CHEST.—A chest filled with bombs, or only with gunpowder, placed underground, to cause destruction by its explosion.

BOMB-LANCE.—A sharp-pointed projectile, used principally in whale-fishing, charged like a grenade, and shot from a musket, the slow fuse that explodes it being first lighted. Its power is sufficient to stun the whale.

BOMB-PROOF.—A term applied to military structures of such immense thickness and strength that bombs cannot penetrate them. Military buildings, generally within permanent fortifications, and which are formed so as to withstand the shock of heavy shot or shell falling on them. Magazines for holding gunpowder should be placed in the most sheltered position within a fortress, and strongly constructed to resist direct and vertical fire from heavy ordnance. In the forts recently built for coast-defense in England, 17 feet of masonry has been considered necessary against direct fire, and an arch 3 feet thick, with 3 feet of concrete over the roof, against vertical fire.

BOMB-PROOF MAGAZINES.—For field-works of a semi-permanent character which are to be indefinitely occupied, have an armament of heavy guns, and are expected to stand a siege,—like the defenses around Washington, for example,—the magazines, bomb- and splinter-proof shelters should be constructed of the heaviest timber, and be covered securely with earth from the assailant's curvated and direct fire. The ventilation of the magazines and precautions for their drainage are of the utmost importance. The drawing shows a cross-section of a magazine con-

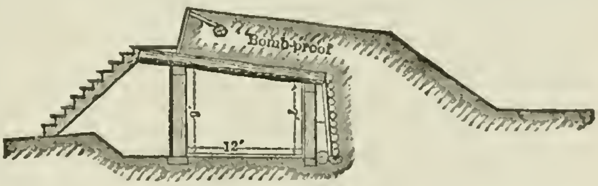


Cross-section of Bomb-proof Magazine.

structed in a work of this character. The sides of the interior of the magazine are formed of twelve-inch logs placed vertically in juxtaposition and resting upon a ground-sill. These are capped on top by a two-inch board, a strip of a like kind being spiked on within the cap. The top is formed of fifteen-inch logs, also in juxtaposition, each having a shoulder of three inches to fit it to the cap and inside strip. Longitudinal logs are laid on these with varying diameters, so as to give a proper pitch for the roof. Earth is solidly packed upon the top and between the roof-logs, receiving the proper slope for the roofing-boards. These boards, carefully jointed, are laid on in two thicknesses, each being covered with a coating of asphalt. The flooring of the magazine is of joists and boards. The sides of the magazine are surrounded with an air-chamber formed by inclined logs supported on a ground-sill and resting against the top logs; these are placed at three or four feet apart, each one being braced at the middle point to resist flexure from the pressure of earth. The chamber is covered in by saplings laid in juxtaposition. There are ventilators between the magazine and the air-chamber near the top, and also between the latter and the external air; the two not being opposite, and the usual precautions to guard against accidents from sparks being taken. The earth-cover is ten feet on the exposed side, and six feet on the other sides and on top. The entrance to the magazine is well secured by a bomb-proof covering. A slope is given from the interior to the foot of the steps leading to the level of the floor for the purposes of draining.

BOMB-PROOF QUARTERS.—Casemated bomb-proof quarters are indispensable to the safety and comfort of the garrison during siege, or any prolonged attack for the annoyance or reduction of the work by a bombardment. In small works like most of our forts, which are chiefly designed for sea-coast defense, casemated quarters have been generally arranged in the rear of the batteries, a portion of each casemate towards the parade being partitioned off and suitably disposed for the object in view. In some cases advantage is taken of a scarp-wall, on a land-front, which is well covered by a glacis or other face-cover, to form in its rear quarters of this character. In all cases care should be taken to place such quarters on those fronts which are best covered from a direct fire, and the parade-walls of which are not exposed to reverse-fire. Whenever the plan of the work admits of it, quarters of this kind should be arranged for defense, by being pierced with loop-holes and even with embrasures for cannon. Defensive casemated quarters form a prominent and distinctive feature in what is now known as the German School of Permanent Fortification.

BOMB-PROOF SHELTERS.—These structures are for the protection of the troops when not on duty. They should be located on the parade, convenient to the pieces to be served, yet not so near as to interfere with the defense. They are usually constructed in half-excavation of logs built up like a log-house, or of a framework in the manner shown in the drawing, the exterior side being of heavy logs placed vertically in juxtaposition, resting on a ground-sill and capped at top. Parallel to this is another row, forming the other side, which may also be placed side by side or at short intervals apart, and capped like the outside row. The roof, consisting of heavy logs laid in juxtaposition and covered with thick boards joined, rests on the capping, the whole covered over on the side of the enemy with earth to a depth of at least 14 feet from the wood-work. To prevent this mass of earth from pushing the structure over to the rear, one in every two or three of the roof-logs is cut of sufficient length to extend about 8 feet beyond the front of the wall, and dovetailed to a longitudinal log held in position by vertical posts, the anchor-log being sufficiently covered with earth to protect it from injury by shot from the enemy. These bomb-proofs are made to serve the purpose of traverses, and are frequently arranged with a staging or gallery along the rear side for the accommodation of infantry, who deliver their fire over the top, arranged for this as a parapet. In all interior arrangements, system and regularity should be observed from the first; otherwise the work will grow into a labyrinth of con-



Bomb-proof Shelter.

fusion greatly opposed to efficiency and comfort. See *Shelters* and *Splinter-proof Shelters*.

BOMB-SHELL.—A hollow globe of iron, filled with powder, and thrown from a mortar. See *Bomb*.

BOND.—A bond, in law, is simple or conditional, the latter being generally used. It must be in writing, and signed, and should be sealed. The condition is the vital part, limiting and determining the amount to be paid or the thing to be done, and no person can take the benefit of a bond except the parties named therein, save in the case of a bond given by an officer for the performance of duty. If a bond runs to several persons jointly, all must join in suit for breach, although the conditions may not at all affect some of them. Recovery against a surety on a bond is not limited to the penalty, but may go beyond as far as necessary to include interest from the time of default. A bond dormant for twenty years cannot afterwards be recovered, the presumption being that it has been satisfied. If the maker of a bond binds himself without adding "heirs," the heirs cannot be held, but the executors and administrators are liable. All Disbursing Officers of the army are required to give bond.

BONE-SPAVIN.—A bony tumor in horses where the head of the splint-bone joins the shank. Inflammation of the ligaments of any of the small bones of the hock proceeding to bony tumor classes as spavin.

BONFIRE.—A fire kindled for some purpose of public rejoicing, usually in an open conspicuous place, as the top of a hill or the center of a village-green. The burning materials consist of tar-barrels, coal, and other combustibles. The practice of kindling fires of this kind is of so great antiquity in England, Ireland, and Scotland as to be traced to pagan rites. The origin of the word *bonfire* has been very puzzling to etymologists. In Scotland the popular term is *banefire* or *bainfire*, which Jamieson says is apparently a corruption of *bailfire*, which may be doubted. The most probable etymology is the Welsh *ban*, high, whence *ban-ffagl*, a lofty blaze, a bonfire. The same hills that in English are called *beacons* are in Welsh called *bans* or *vans*. In Danish, also, *baun* is a beacon, and may be traced in such names as *Banbury*.

BONING-STAFF.—A T-headed staff, used in conjunction with a plummet and line for taking short levels.

BONNET.—1. In fortification, a small defense-work constructed at the salient angles of the glacis or larger works. It consists of two faces only, with a parapet three feet high by ten or twelve broad. There is no ditch. A larger kind, with three salient angles, is called a *priest's bonnet*, or *bonnet à prêtre*. The use of the bonnet is to check the besiegers when they are attempting to make a lodgment. See *Bonnettes*.

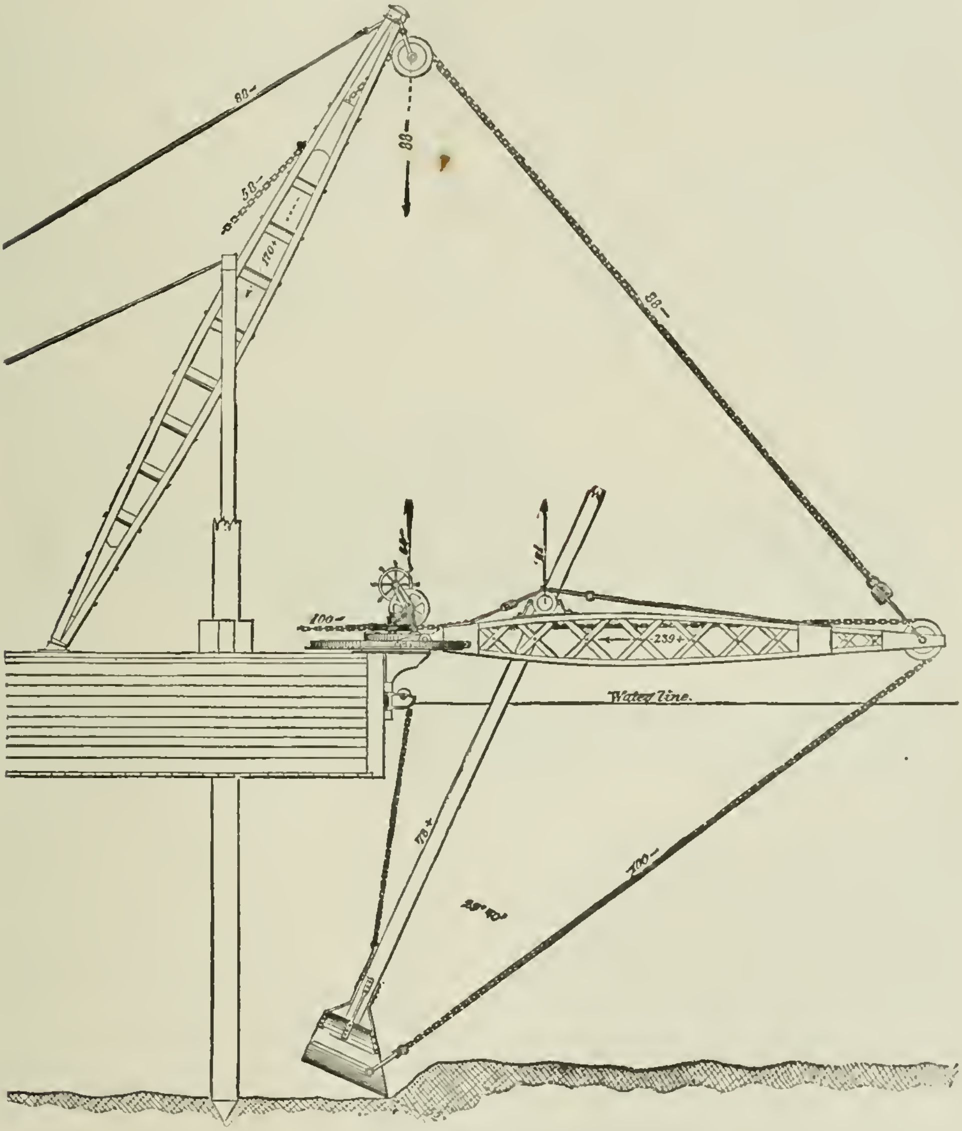
2. A covering for the head, of which there are many varieties. The French, from whom we have the word, apply it as we do to male as well as female head-dress. From the frequent notice of the blue bonnet in historical records and in song, it would seem that the Scotch were long identified with this kind of head-covering. The genuine old bonnet of the Lowland Scottish peasantry was of a broad, round, and flat shape, overshadowing the face and neck, and of a dark blue color, excepting a red tuft like a cherry on the top. The fabric was of thick milled woolen, without seam or lining, and so exceedingly durable that, with reasonable care, a single bonnet worth about 2*s*. would have served a man his whole life. No head-dress ever invented could stand so much rough usage. It might be folded up and put in the pocket, or laid flat and sat upon, with equal impunity; it might be exposed to a heavy drenching rain without the head being wetted, and when dried it was as good as ever. Besides it could be worn on the top of the head, or slouched in front, behind, or sidewise, as a protective against a cold blast; and from its softness and elasticity it very fairly saved the head from the effects of a blow. In short, there was no end to the adaptability of the old "braid bannet," as the Scotch termed it; and one almost feels a degree of regret that, in the progress of fashion, it should have gone so much out of use. The Highlanders have long worn bonnets of the same fabric, but these rise to a point in front and are without any rim. Such is the cap now known as the *Glengarry bonnet*. From time immemorial, these various kinds of Scots bonnets have been manufactured at Stewarton, a small town in Ayrshire. Formerly the Stewarton bonnet-makers formed a corporation, which, like other old guilds, was governed by regulations conceived in a narrow and often amusingly absurd spirit; one of the rules of the fraternity, however, can be spoken of only with commendation, for it enforced a certain weight of material in each bonnet, as well as durability in the color. The bonnets used in the Highland regiments are made at Stewarton and Kilmarnock; they are usually distinguished by a checkered fillet, being the *fess-cheque* of the House of Stuart. Latterly, although hats and caps have, to a great extent, superseded bonnets of the old varieties, the bonnet-manufactories of Stewarton have much increased, and are still increasing.

BONNETTES.—It is frequently desirable that the height of the parapet, at certain points, should be increased for a short distance. This increase is generally obtained by making use of the constructions known as bonnettes. A bonnette extends but a short distance along the parapet, is made of earth, and is used generally to give greater protection to the men standing on the banquette against a slant or an enfilading fire of the enemy. Bonnettes are placed usually on the salients; they are sometimes placed on the parapet between guns *en barbette*. They may be constructed during the progress of the work, or after the work has been finished. In the former case their construction is, to all intents and purposes, similar to that of the parapet. In the latter case they are constructed generally in haste, and sand-bags or gabions filled with earth are used to build them.

BONTCHOUK.—A lance ornamented with a horse's tail. When the kings of Poland led their armies, bontchouks were carried before them.

BOOM.—A strong chain of timber logs or iron employed in barring the passage of the mouth of a harbor or river, or to cut off the retreat of an enemy if he has actually entered. Such a boom should be protected by a battery or batteries. There should be two such chains, one to afford resistance if the enemy has penetrated the other; they need not extend all across the passage, seeing that shallow spots are self-defended. A modern war-steamer would cut through a chain-boom, unless made of very thick and strong iron. Sometimes hempen cable-booms are used to resist small-craft. The Russians effectually boomed the harbor of Sebastopol in September, 1854, thereby preventing the entrance of English and French ships; this was done partly by sinking some of their own ships, and partly by the laying of booms.

BOOM-DREDGE.—This machine, recently given to the public by its inventor, Mr. Ralph R. Osgood, of Troy, N. Y., and built by the Osgood Dredge Company, is destined to effect a revolution in dredging methods and operations. Its general outline is shown in the drawing, as also the essential working elements, and the strains to which the various parts are subjected. In this machine we have the dipper and handle essentially the same as in the crane-dredge. The dipper-handle is held in position by a friction-clutch, of Mr. Osgood's design and patent, placed on top of the boom near to the boat. The excavating power is applied to the dipper by means of a chain running over a sheave at the outer extremity of the boom, and thence along the boom to the hoisting-drum on deck. The boom is pivoted or hinged to a turn-table at the boat end and supported at its outer end by a chain passing to an overhead-pulley, pendant from the combination of timber A-braces and iron ties. This chain is worked by a drum, and therefore allows the boom to take any position required by the caprice of the operator. The strains are based upon the tension occurring in the hoisting-chain, taken at 100. Compressive strains are denoted by a +, while those of a tensile nature are indicated by a −. Each degree is assumed to be working in 25 feet of water. In the boom-chain a 15-ton steel spring is placed, through which all shocks and jars must pass before reaching the machinery. This adds greatly to the life of the machine. The boom can swing and operate through a complete semicircle. The hoisting-chain can be changed from the intermediate sheave to the sheave at the outer end of the boom, for delivering on banks. The boom can be raised or lowered by means of the chain connecting it with the A-frame. The turn-table is made of iron, and is mounted on friction-rollers which greatly reduce the strain of swinging. All the different levers for working the throttle, spud and hoisting-drum frictions, for swinging the turn-table, etc., are placed near together and are operated by one man. The peculiar advantages of this machine will be readily comprehended from the brief description which has been given. They lie in the fact that material can be dredged at greater depths, raised higher, and dumped further from the center of the dredge-boat than is practicable with any of the old-style crane-dredges. The advantages may be briefly stated as follows: 1. Greater pulling force or excavating power in the direction of the bank. 2. Less strain in the dipper-handle and hull of boat. 3. Less loss of power by frictional resistances. 4. Greater rapidity in delivering the dipper-contents, thus making, other things being equal, greater capacity. 5. Dredges on the half-circle. 6. With the same length of dipper-handle as the crane-dredge has, can dredge in deeper water. 7. With a slight additional expense, may be made to work as a "clam-shell" dredge. See *Crane-dredge, Dredging-machine,* and *Excavator.*



Osgood Boom-dredge.

BOOMERANG.—A missile instrument for war, sport, or the chase, much used by the aborigines of Australia. It is of hard wood, of a bent form; the shape is parabolic. It is about two and a half inches broad, a third of an inch thick, and two feet long, the extremities being rounded. One side is flat, the other rounded; and it is brought to a bluntish edge. The method of using this remarkable weapon consists in throwing it in a particular manner. It is taken by one end, with the bulged side downward and the convex edge forward, and thrown directly onward, as if to hit some object thirty yards ahead. Instead of going directly forward, as might be expected, and there falling to the ground, it slowly ascends in the air, whirling round and round, and describing a curved line of progress till it reaches a considerable height, when it begins to retrograde, and finally it sweeps over the head of the projector, and falls behind him. This surprising motion is produced by the bulged side of the missile. The air impinging thereon lifts the instrument in the air, exactly as by hitting the oblique bars in a windmill it forces it to go round. The ingenuity of the contrivance, which is worthy of the highest scientific calculation, is very extraordinary as coming from almost the lowest race of mankind. The boomerang is one of the ancient instruments of war of the natives of Australia. They are said to be very dexterous in hitting birds with it, the animals being of course behind them, and perhaps not aware that they are objects of attack. This curiosity, as it must be called, was first made known by being brought before the Royal Irish Academy by Prof. M'Cullagh in May, 1837.

BOOMING OUT.—A method of constructing a ponton-bridge. A frame of two saddles, connected by their balks, is prepared on shore: a ponton being launched, the frame is lifted up, and the ponton is brought under the first saddle, and fastened to it; in the mean while the balks of another frame are bolted to a third saddle, the bridge is *boomed out*, and a second ponton is fixed under the second saddle, and so on. The bridge is kept in its proper position by means of ropes secured to anchors.

BOOTS AND SADDLES.—A sound on the trumpet which is the first signal for mounted drill, and for all other formations mounted; it is also the signal for the trumpeters to assemble. In the English service, it is a parade-call in the cavalry and artillery, sounded half an hour before the turn-out.

BOOTY.—Despoiling a people or city is barbarous and not tolerated in civilized warfare, but legitimate subjects of booty are well described in an Act of the British Parliament; as, arms, ammunition, stores of war, goods, merchandise, and treasure belonging to the *State* or any *public trading company of the enemy*, and found in any of the fortresses or possessions, and all ships and vessels in any road, river, haven, or creek belonging to any such fortress or possession. It should be the duty of Commanding Generals to cause an exact account of such captures to be kept, in order that the captors may be remunerated by the Government for such stores as are reserved for the public service, and in order that *all* such prizes of war may be legally and equitably divided amongst the captors. Such is the practice in England. There land-prizes are divided according to an established rule of division. In the Piedmontese army the administration of booty is intrusted to a special Staff Corps; the French laws (says Bardin, *Dictionnaire de l'Armée de Terre*) are silent on this subject, or else those which are in force announce nothing positive; and in their silence there is inhumanity, hypocrisy, and mental reserve. In a memorial presented by the Duke of Wellington, he claimed of his Government for the English army more than a million sterling which had been used in the king's service from captures made by the British army in Spain and France, and the English budget of 1823 shows that the amount so claimed was given to the army. An Article for the government of the armies of the United States provides that "All public stores taken in the enemy's camp, towns, forts, or magazines, whether of artillery, ammunition, clothing, forage, or provisions, shall be secured for the service of the United States; for the neglect of which the Commanding Officer is to be answerable." This Article of War is borrowed from a corresponding British Article, which directs that the same stores shall be secured for the king's service. But by proclamation in Great Britain the money-value of all captures is invariably divided amongst the captors. No practice can be more wise and just; for although it is necessary to proscribe *marauding* or *pillage*, it is impossible to extirpate the desire of gain from the human heart, and it is therefore necessary that the law should frankly provide for an equitable distribution of captures amongst the army. The absence of a law of division tends to introduce into an army the greatest evils: soldiers disband themselves in search of pillage, and their cupidity leads to the greatest horrors. These great evils are avoided by a legal division of booty, when all soldiers, animated by the hope of sharing the fruits of victory, are careful not to abandon to the greedy, the cowardly, and the wicked amongst themselves advantages properly belonging to the gallant victors. See *Prize*.

BORDURE.—In Heraldry, coats of arms are frequently surrounded with a bordure, the object of which is generally to show that the bearer is a cadet of the house whose arms he carries. The character of the bordure often has reference to the profession of the bearer: thus, a bordure *embattled* is granted to a soldier; and a bordure *ermine*. to a lawyer. Also written *Border*.

BORE.—The internal cavity of a cannon, mortar, howitzer, rifle, musket, fowling-piece, pistol, or other kind of fire-arm. It is in most cases cylindrical; but in the Lancaster gun the bore is oval; in the Whitworth gun it is hexagonal; while in the Armstrong and many other kinds of gun it is furrowed by spiral grooves. Technically, the bore of a gun often means simply the diameter of the cavity, as when we speak of a gun "of 8-inch bore;" and in that case its meaning is equivalent to "caliber."

The Boring of a cannon is a process which may best be described in connection with Cannon-founding and Boring-machine. It is desirable to mention in the present place, however, that there is an operation called "boring-up" conducted at Woolwich Arsenal, for enlarging the bore of a gun. It has been found in recent years that many of the old cannon are thicker and heavier than needful for the size of shot propelled, and that they could be fitted for the discharge of larger shot without danger. A change was begun in the armament of the British fleet in 1839 by substituting heavier broadsides; and as one part of the process, many of the old 24-pounders were "bored-up" to 32's; even some of the 18-pounders were found to be thick and strong enough to undergo this process. More than 2000 iron naval guns were thus treated at Woolwich preparatory to the change in 1839; and many others have since been similarly bored-up. About 1860, important experiments were carried on at Woolwich, to determine whether the old smooth-bore iron guns could not only be bored-up, but *rifled* at the same time. There were 15,000 of such guns belonging to the British Government, and it was suggested that they ought to be improved, instead of being cast aside as useless in the event of the success of the Armstrong and Whitworth guns. The process has not proved altogether satisfactory.

BORERS FOR FUSES.—Instruments for boring out fuses. There are two kinds, termed *hook* and *hand* borers; the former consists of a hook into which the fuse is placed, and a shank which contains a female screw. The bit passes through the center of the handle and male screw, and it is secured by a small screw which presses upon the bit. The hand-borer is a simple instrument, somewhat like a hand-gimlet, but the blade is fluted and not spiral. This instrument is supplied to each gun.

BORI.—A Turkish term for military trumpets and other similar instruments.

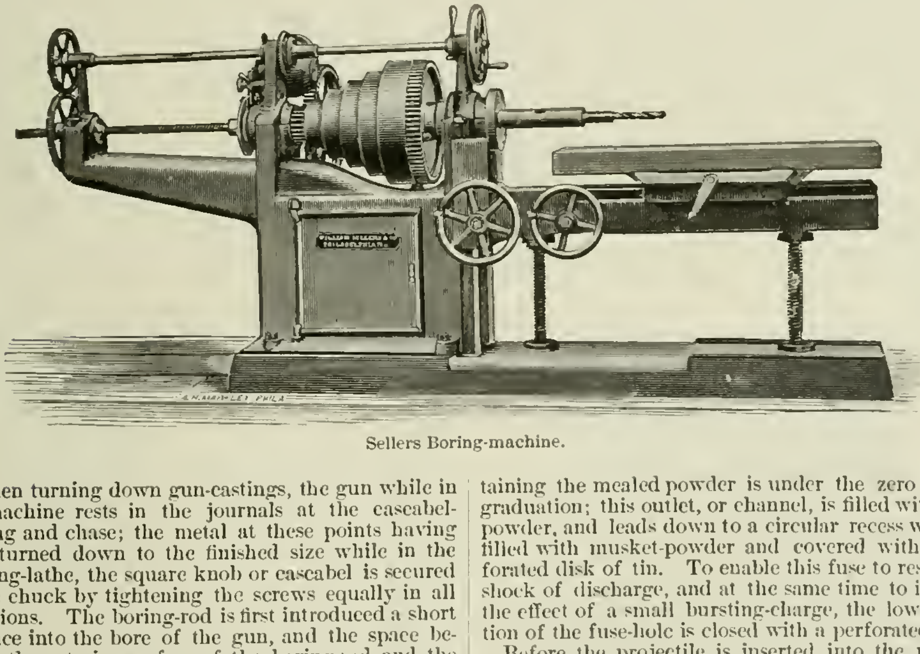
BORING-MACHINE.—This machine, designed to bore and drill horizontally work resting on a table or platform, has been considered by Engineers and Ordnance Officers as coming next to the lathe in usefulness in the armory. It should drill work that cannot be operated on in an ordinary vertical drill-press, and have all the advantages of a facing-lathe for some kinds of work.

Marked advantages which the Sellers machine (see cut) has over similar tools lie in the nature of the feed-motion, which, by use of the friction feed-disks, admits of an infinite variety of feeds between its finest and its coarsest; in the ready application of the feed, and its quick hand-motion; also in the manner of operating the compound table upon which the work rests, the handles to govern the motion of table being all on one side and within easy reach of the workman. The screws which raise the table require holes in the foundation below the bed; as when the table is lowered they project below the base of the machine. If placed in damp places, the boxes or recesses in foundation for these screws should be made water-tight. The machine is provided with an out-board bearing when that style of machine is required. This bearing is carried from the bed-plate, arching over the knee which carries the table; it bolts to the bed-plate, and to the knee also. It can be placed 29 inches from the face-plate, or it can be moved off to 53 inches from the face-plate; it does not interfere with the ready adjustment of the table vertically. The feed-motion now applied is arranged in two series, a fine and a coarse, both of these series being applicable to any speed or any size of drill. The value of the coarse feed will be felt in all kinds of boring with bars and cutters, inasmuch as it is possible to rough out with a fine feed, and to finish with a light cut and a very coarse feed. In this way the finishing cutter is hurried through the work, is less liable to wear in the length of the hole to be bored, and much time is saved.

ping and filing. To insure a smooth surface in the bore, all the work on the exterior surface of the gun is suspended while the reamer, or finishing-tool, is being used. The boring being completed, the *cylinder-gauge* is inserted before removing the gun from the lathe, to ascertain if it passes freely to the bottom of the bore; the chamber-reamer should also be measured after use in each gun, and if found correct the gun is moved from the lathe.

A general difference in the style of the tools between those employed for wood and those for metal gives opportunity for distinguishing between the two classes of machines, although the modes of propulsion in some machines of the respective classes are very similar, and the boring *bits* for hard wood are much like the *drills* for metal. See *Drilling-machine* and *Heading-lathe*.

BORMANN FUSE.—This fuse is the invention of an officer of the Belgian service. The case is made of an alloy of tin and lead, cast in iron molds. Its shape is that of a thick circular disk; and a screw-thread is cut upon its edge, by which it is fastened into the fuse-hole of the projectile. The upper surface is marked with two recesses and a graduated arc. The former are made to receive the prongs of a screw-driver; and the latter overlies a circular groove, filled with mealed powder, tightly pressed in and covered with a metal cap. The only outlet to the groove con



Sellers Boring-machine.

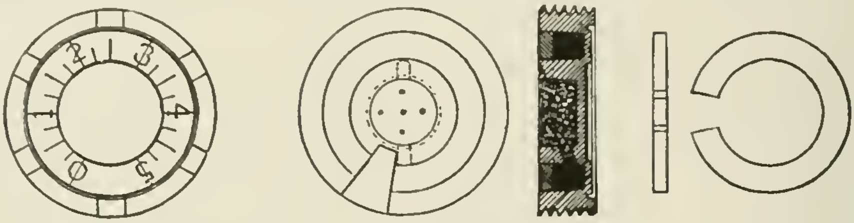
When turning down gun-castings, the gun while in the machine rests in the journals at the cascabel-bearing and chase; the metal at these points having been turned down to the finished size while in the heading-lathe, the square knob or cascabel is secured in the chuck by tightening the screws equally in all directions. The boring-rod is first introduced a short distance into the bore of the gun, and the space between the exterior surface of the boring-rod and the exterior surface of the gun at the muzzle observed. For this purpose a thin wooden gauge is used, pointed at one end and having a notch at the other, which takes the outer surface of the gun at the muzzle, the gauge being laid on the face of the muzzle, and, of course, perpendicular to the axis of the bore. As the gun revolves, the distance above, below, and on either side is observed, thus verifying the perfect concentricity of the axis of the gun at the muzzle. The adjustment is completed at the breech, by slackening the bolts at the cascabel-bearing, leaving it free to move on the rest; and should any lateral motion be perceptible, it is corrected by adjusting the screws in the chuck, after which the concentricity is complete from breech to muzzle. During the process of boring, the turning continues, and the exterior is finished, except between the trunnions and about the lock and sight-masses; the former being planed off by a machine for the purpose, and the latter reduced by chip-

taining the mealed powder is under the zero of the graduation; this outlet, or channel, is filled with rifle-powder, and leads down to a circular recess which is filled with musket-powder and covered with a perforated disk of tin. To enable this fuse to resist the shock of discharge, and at the same time to increase the effect of a small bursting-charge, the lower portion of the fuse-hole is closed with a perforated disk.

Before the projectile is inserted into the piece, a cut is made across the graduated portion, laying bare a small proportion of the mealed powder, which, being ignited by the flame of the charge, burns in both directions until the outlet is reached and the grain-powder ignited. The graduations are seconds and quarter-seconds, and the time of burning of the fuse depends on the length of the column of mealed powder included between the incision and outlet. If the metal covering be not cut, the projectile may be fired as a solid shot. The Bormann fuse is used for the field and siege services, and is found to be accurate and reliable, especially for spherical-case shot. The time of burning not being long enough for the general service of rifle-projectiles, the paper time-fuse is used instead of it for all of those projectiles which require the time-fuse. It is inserted into a zinc plug, which is screwed into the fuse-hole of the projectile.

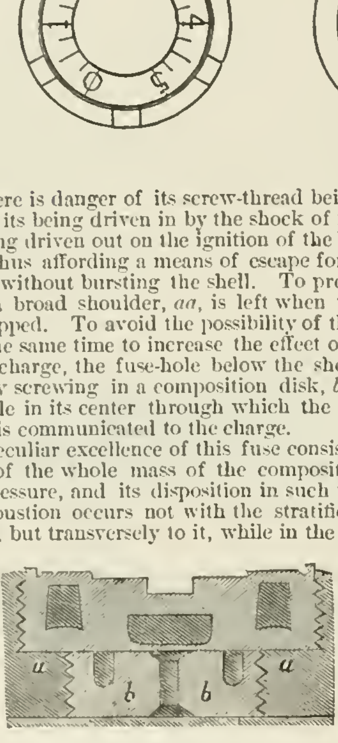
The action of the Bormann fuse is as follows: The thin covering of metal above the composition is cut so as to lay bare the upper surface of the composition, and to afford the flame access to it at the part desired. The cut should be made with the fuse-cutter close to the right of the mark in the index-plate; and it is best made in two or three efforts instead of trying to effect the cut at once. The combustion occupies the assigned time in passing from the incision towards the origin of the graduation, when it traverses the orifice leading into the magazine, the contents of which explode smartly towards the interior, and then encounter instantly the charge in the shell.

The metal of this fuse being soft and its diameter great, there is danger of its screw-thread being stripped, and its being driven in by the shock of firing, or of its being driven out on the ignition of the bursting-charge, thus affording a means of escape for the gas evolved, without bursting the shell. To prevent the former, a broad shoulder, *aa*, is left when the fuse-hole is tapped. To avoid the possibility of the latter, and at the same time to increase the effect of a small bursting-charge, the fuse-hole below the shoulder is closed by screwing in a composition disk, *b*, with a small hole in its center through which the fire from the fuse is communicated to the charge.



Bormann Fuse.

The peculiar excellence of this fuse consists in the driving of the whole mass of the composition by a single pressure, and its disposition in such wise that the combustion occurs not with the stratification of the mass, but transversely to it, while in the ordinary fuses the solidification and the process of combustion are just the reverse; that is, the column is composed of a number of layers solidified successively by an equal pressure; but as the inferior layers have, besides the pressure applied to them, to bear that of the superincumbent layers, it follows that the mass is not homogeneous, but increases in density with the inferior position of the layers. See *Fuse* and *Time-fuse*.



Shoulder and Disk.

BOSHES.—The sloping sides of the lower part of a blast-furnace, which gradually contract from widest part of the furnace to the hearth. In a furnace 55 feet high and 38 feet wide at the base of the structure, the boshes will be about 8 feet in perpendicular height, 12 feet wide at the top, and 2¼ feet at the bottom where they join the hearth. The boshes are built of a coarse-gritted freestone, abounding in small nodules of quartz. A number of newly invented puddling and boiling furnaces have iron floors and boshes. A current of water is caused to circulate in them to prevent destruction of the iron under the extreme heat. The material which is banked up against the boshes to protect them from the heat is called *fixing*. It consists of scrap and ore, and receives a preliminary melting. One *composition for fixing* furnaces consists of finely pulverized ore and German clay made into a paste; and another for the same purpose is a paste made by grinding the ore and rendering it plastic by moistening and working. *Bull-dog* is a decomposed protosilicate of iron used in England and France for this purpose.

BOSNIAKEN.—Formerly light cavalry of the Prussians, resembling the present Uhlans. Frederick I. formed this cavalry in 1745.

BOSS.—1. A stud or ornament raised above the leather-work of a cavalryman's horse-trappings. 2. A protuberance raised as an ornament on any work; the part rising in the center of a shield. 3. A plate of cast-iron secured to the back of the hearth of a traveling-forge. 4. In architecture, a raised ornament covering the intersections of the ribs of ceilings. They are more frequently seen in vaulted roofs, as in the aisles of a church, but occur also where the ceiling is flat. In early Norman work there are generally no bosses, and they become richer and more frequent as we advance towards the decorated and perpendicular styles. In the decorated style the boss usually consists of foliage, sometimes combined with animals, heads, and the like. Coats-of-arms, charged with armorial bearings, came then also to be used for this purpose, though they were more frequent in the perpendicular.—The boss was borne in the arms of the Corporation of Lorimers. See *Lorimer*.

BOSSE—BOSSE A FEU.—A term used in the French Artillery to express a glass bottle which is very thin, containing four or five pounds of powder, and round the neck of which four or five matches are hung after it has been well corked. A cord two or three feet in length is tied to the bottle, which serves to throw it. The instant the bottle breaks, the powder catches fire and everything within the immediate effects of the explosion is destroyed.

BOSSETTES.—In horse-armor, the ornaments on the side of the bit. The term is also applied to the pieces of leather, or blinkers, which cover the eyes of the mule.

BOSTANJI.—A class of men in Turkey who, originally the Sultan's Gardeners (the name being derived from *bostan*, a garden), now perform, in addition to their garden-labor, a variety of duties, such as mounting guard at the Seraglio, rowing the Sultan's barge, and attending on the Officers of the Imperial Household. They are under a Chief called Bostanji Bashi, who holds the rank of a Pasha, and is Governor of the Sultan's residences, and Steersman of his barge. He also holds the Inspector-generalship of the woods and forests in the vicinity of the capital, has the jurisdiction of the shores of the Bosporus and Sea of Marmora, and is, altogether, so important a functionary that only personal favorites of the Sultan can hope to fill the office. The financial reforms of Sultan Mahmoud, however, have greatly lessened the emoluments of the post. The Bostanji at one time amounted to 5000, and were divided into companies like the Janissaries, with whom they were united in military duty. In war-time their strength was 12,000. A scarlet bonnet, of excessive dimensions, formed the distinctive part of their costume. Their number now does not amount to more than 600.

BOTHWAY BLOCKS.—Two natures of these blocks have been introduced into the English service, the 18- and 15-inch. They are each *single*, *double*, and *treble* blocks. These blocks in the land-service have superseded the ordinary common blocks of 18 inches and upwards, but the existing store of iron gyn blocks will be used up. Bothway's blocks are made of the best English elm; the swivel, hooks, and shackles, of the best manufactured scrap-iron; the straps and pins for sheaves, also connecting-pins, of the best iron; and the sheaves, of phosphor-bronze. See *Blocks*.

BOTONE.—In Heraldry, a cross botoné is a cross of which the ends are in the form of buds or buttons. Also written *Botonny*.

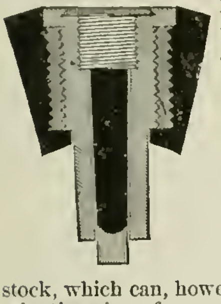
BOTTLE-NECKED CARTRIDGE.—The name given to the Martini-Henry cartridge, from its bottle-necked shape. The neck or smaller diameter of the cartridge-case is formed by means of a die so arranged as to form flutes or folds in that part of the case, and consequently reduce the diameter: the paper covering is dispensed with, a paper lining being substituted.

BOTTOM.—1. A circular disk with holes to hold the rods in the formation of a gabion. 2. One of the plates by which grape or canister is built up into a cylinder suitable for loading into the gun: cast-iron tops and bottoms for grape, wrought-iron for canister.

BOUCANIER.—A long, heavy musket used by the American Buccaneers, and with such skill as to give the weapon a high degree of celebrity.

BOUCHE.—1. The aperture or mouth of a piece of ordnance,—that of a mortar, of the barrel of a musket, and of every species of fire-arms from which a ball or bullet is discharged. 2. A cylinder of copper in which the vent of a piece of ordnance is drilled. It has an exterior screw-thread cut on it, so that it may be removed when the vent becomes worn, or a new bouche substituted. Also written *Bouch* and *Bush*.

BOUCHING.—The fuse-holes of shells are frequently bouched with gun-metal to receive the fuse-stock. In fitting the shell to receive the bouching, the bore should be tapped with a full thread, and the proper shoulder left at the bottom to prevent the bouching from being driven in by the shock of firing and causing premature explosion. The object of the bouching is to prevent rust, and to have the same kind of metal in contact with the fuse-stock, so that there will be less danger in extracting or exchanging a fuse. The fuse-holes of heavy rifle-shell are necessarily cast larger than the diameter of the regular fuse-stock, which can, however, be used with the aid of an *adapting-ring* of gun-metal, which is screwed in to reduce the diameter of the hole to the proper dimensions. The 15-inch spherical shell are cast with three fuse-holes equally distant from each other, and situated in the angles of a triangle 4 inches apart. See *Fuse-hole* and *Shells*.



BOUCHING-BITS.—Instruments used for boring a hole in the vent field of guns, to receive the copper plug, or bouch, through which the vent is afterwards drilled.

BOUGE.—An ancient war-club, the head of which was loaded with lead; also called *plombée*, and frequently written *Boulge*.

BOULAF.—A kind of baton or very short mace, formerly used by the Polish Generals.

BOULENGE TELEMETER.—The Boulengé telemeter is an instrument devised for ascertaining the distance to a point by means of sound proceeding from the point to the place of observation. The one used for artillery purposes consists of a glass tube about six inches in length, filled with a transparent liquid that does not freeze except with intense cold. In the liquid is a metallic disk, which moves freely from one end of the tube to the other. It is so adjusted that the motion will be uniform and comparatively slow. The tube is inclosed in a brass case, to which is attached a scale, after the fashion of a thermometer. This scale is marked for each hundred yards up to 4000. The divisions on the scale show the distance, in yards, through which sound will travel in air, during the time required for the disk to descend over the space on the scale marked by the corresponding number of yards. If, for instance, the disk passes from zero to the 500 mark, it indicates that sound would have traveled 500 yards through the air during that time. The instrument must be held vertically, or as nearly so as possible. To arrest the motion of the disk at any point, the instrument is quickly turned to a horizontal position.

To use it for determining the time of flight of shells, it is held in the right hand, back of the hand up, with the zero of the instrument to the left; a turn of the wrist to the right brings the instrument vertical, with the zero end uppermost; the disk then descends, and a turn of the wrist to the left arrests its motion. The observer, holding the instrument as described, watches for the flash of the shell, and upon seeing it, instantly brings the instrument to a vertical position; upon hearing the report from the shell, he instantly turns it back again. The position of the disk indicates the number of yards from the observer to where the shell exploded. To ascertain the distance to an enemy's battery, the instrument is held and turned in the same manner. The observer watches for the flash of a gun; observing which, he turns the instrument, and, when he hears the report, turns it back and reads off the distance. Each hundred yards on the scale is subdivided into quarters. See *Le Boulengé Chronograph* and *Telemeter*.

BOULEVARD—BOULEVART.—The name given in France to the old fortifications, ramparts, etc., with which towns, or portions of them, were, or still are, surrounded. In France and Germany these ancient works have generally been leveled, the ditches filled up, and the space thus obtained employed for the formation of parks, promenades, and streets lined with trees. These, however, in France still bear the name of *boulevard*. The boulevards of Paris are celebrated, and are of great service as open spaces promoting the circulation of air amidst the dense mass of habitations. Some parts of them present a very dazzling spectacle, and as a whole they afford a striking exhibition of the life and character of the French Capital in all the different classes of society. The *Boulevard des Italiens* is particularly known as the rendezvous of the fashionable, and the *Boulevard du Temple* as the place where the small theaters are to be found which are frequented by the common people and the inhabitants of the suburbs, for which reason the expression *Théâter de Boulevard* is often employed to denote a theater for the common people, or one of an inferior kind. The Thames Embankment is essentially a boulevard.

BOUND.—In gunnery, the path of a shot comprised between two *grazes*.

BOUNTY.—A sum of money given to encourage men to enter the army or navy. In time of peace, when there is little or no need to augment the forces, the bounty sinks to a minimum; but in cases of exigency, it is raised according to the difficulty and urgency of the circumstances. In the British army no bounty was paid to recruits until about half a century ago; the temptations offered to them, if any, were of some other character. The highest bounty ever paid during the great wars against Napoleon was in 1812, when it amounted to £18 12*s*. 6*d*. for limited service, and £23 17*s*. 6*d*. for life; but these sums were in great part nominal, being subject to many unfair and absurd deductions. Even so late as 1849, when the bounty to an infantry recruit was nominally £4, he received little more than one eighth of this amount, all the rest being swallowed up in fees and drawbacks of various kinds. The only bounty which now exists is a free kit—no other being allowed. The young men who used to enter the British army were supposed, for the most part, to have been tempted by immediate bounty rather than by prospective pay and pensions; and thus it arose that the rate of bounty varied frequently, while those of pay and pensions underwent very little change. In 1855 it was £7 per head (for line infantry); in 1856, only £2; in 1858, £3; and it afterwards underwent further changes. It was always higher to the cavalry and artillery than to the infantry; and in the latter it was higher to the Highland than to the other regiments, on account of matters connected with dress and personal ornaments. The term *bounty* is also used in the navy to signify the payment and distribution of money to which the officers and crew of Her Majesty's ships and vessels of war may, on particular occasions of active service, be entitled. See *Prize*.

BOURBON FUSE.—This fuse consists of a bronze fuse-plug screwed into the eye of the shell, with a head larger in diameter than the other part and threaded on the exterior, by means of which a cap is screwed on, covering the fuse until just before it is used. A cap of copper is fixed to the head of the fuse by means of several circular grooves in the fuse-plug; slots and projections being formed on the edge of the cap, and the rabbets of the circular grooves, which allow the cap to be inserted in its place. A threaded hole is placed at the highest point of this cap, in which the fulminating-cap is screwed just before the fuse is used. A steel nipple is screwed into the body of the fuse just under the cap, which, when the cap is exploded, conveys fire to the charge, communicating it first to the powder contained in the channel of the fuse. The bottom of this channel is closed with a cork stopper, which is blown out when the powder in the fuse takes fire. The projectile being supposed to strike with the point first, the shock, in order to explode the cap, must be of sufficient force to flatten the cap; and this cap has been made of such a thickness that nothing less than striking against a fortification or other equally resisting body is sufficient to cause explosion. Ricochets could seldom cause the shell to burst. Such a fuse is evidently good for all projectiles with arrangements to keep particular parts always to the front. See *Fuse*.

BOURDONNANTE.—A name formerly given to a kind of bombard of a heavy caliber.

BOURGUIGNOTE.—A helmet worn by the Burgundians, and from whom it was named. It was of polished iron, with a visor. Under Louis XIV. their head-dress was changed to a kind of bonnet. Also written *Bourgenot* and *Bourgignotte*.

BOURLETTE.—In antiquity, a mace which was garnished with iron points.

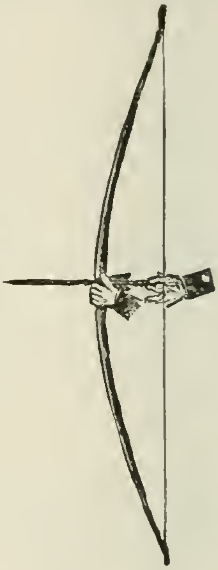
BOURNOUSE.—The Arabic name of a garment worn in Algeria, Morocco, and other parts of northern Africa, and which constitutes a part of the military clothing of some corps of the French army. It is a large woolen mantle, worn above the other attire of the natives, and having a hood, which is thrown over the head in rainy weather. The bournouse is generally white, though distinguished individuals wear it of various colors—blue, green, red, etc. It has been long in use among the Spaniards under the name of *albornoz*. Through the conquest of Algeria by the French, the bournouse was imported into France and England, although its original form has been considerably altered. Also written *Bournous, Burnoose*, and *Burnos*.

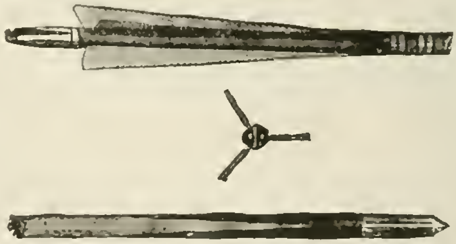
BOUSMARD BASTION SYSTEM.—This system of fortification possesses remarkable features. Taking the enceinte of Vauban's first system, both the crest of the flank and the original face are divided into eight equal parts, being respectively 6, 8, 10, 12, 14, 16, 18, and nearly 20 yards in length. The new faces are composed of eight broken lines. The tenaille has flanks without either terre-plein or banquette. The casemates are skillfully disposed, and their rear is protected by the shoulder-angle of the bastions. The main ditch is reduced to 20 yards, in order that the defenders may throw hand-grenades into the lodgment of the enemy on the covered-way. The covered-way is traced in cremaillère, and extends along the counter-scarp of the main ditch. The traverses have the form of sedans, and the ravelin is detached beyond the glacis of the enceinte. The great defect of this system is that the ravelin and its reduit are liable to be taken by the gorge.

BOUTEROLLES.—The richly decorated termination of ancient sword-scabbards. The figures of lions or other animals, having their bodies stretched out in the direction of the sword-blade, impart a bold and effective finish to the bouterolle.

BOUTON.—A kind of war-club, formerly used by the Caribs of the Antilles. Also written *Boutoou*.

BOW AND ARROW.—In the article Archers will be found a brief account of the military arrangements under which bowmen formed a component element in the armies of the Middle Ages; and under Arbalest is a description of the cross-bow, which was once so favorite a weapon. We here describe the more effective though simpler implement. The long-bow first gained ascendency in England in the fourteenth century. It was found that a dozen arrows could be discharged from this weapon while the Arbalester was winding up his cumbrous cross-bow and discharging one arrow or quarrel from it. Moreover, the long-bow being held vertically, the bowmen were able to stand in closer array than the Arbalesters; they were enabled also to take a greater supply of the munitions of war into the field, seeing that the bow and arrows were much lighter in weight. In the time of Edward III. a bow was priced 1*s*. to 1*s*. 6*d*., and a sheaf of arrows, 1*s*. to 1*s*. 2*d*. In the time of Henry VII. the price (fixed by law) of the bow varied from 6*d*. to 3*s*. 4*d*. The last-named monarch adopted extraordinary means for encouraging the use of the long-bow. Many ordinances were issued for insuring a good supply of bow-staves. The bowyers, string-makers, fletchers, and arrow-head makers were all placed under stringent regulations. Merchants were compelled to import good bow-staves with cargo, in certain proportions. Very long bow-staves were admitted duty free. Yew was considered the best





wood; but in order that the supply should not be too speedily used up, bowyers were ordered to use elm, ash, and witch-hazel in certain proportions to yew. The heads of families were bidden to provide bows for their sons and servants; and town-councils or officers were required to provide shooting-butts just

Bow and Arrow, Ancient Weapons, etc. 1. The Black Prince at Crecy. 2. British Archers. 3. Battle at Paria, French knights attacked by Spaniards. 4 Hussite wagon-fort. 5. German or black knight. 6. Spanish Arquebus man. 7. Tipstaff. 8. Falconet. 9. Italian knight with fire-arm (15th century) 10. Cannon (14th century). 11. Jack-snake 12. Jack-hook (15th century). 13. Tarras musket (Switzerland). 14. Tipstaff with three-barrelled portable gun. 15. Mortar 16. Loading shovel 17. Rammer. 18 Sponge 19 Fire arrow. 20. Hand-spike 21. Gunner's helmet. 22 Rammer. 23. Repeating arm for close firing. 24 Tipstaff's sword. 25 Knight's sword. 26. Hussite weapon. 27 Halberts. 28 Partisans. 29 Battle-axes. 30. Hussite Weapons. 31. Battle clubs. 32, 33, 34, 35. Wall, hooked, chamber and tinder musket. 36. Bullet-molds. 37. Powder-flasks.

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outside each town. Some of the bows had two arches, connected by a middle straight piece. The best length was regarded as about 5 feet 8 inches from nock to nock; but in earlier times some of the bows were much longer. The first arrows were made of reeds; these materials were afterwards superseded by cornel-wood; but the wood finally adopted as the best was ash. The arrows had heads pointed with steel, sometimes barbed to render their action more terrible. They were feathered with portions of goose-wing. The best length for a bow of the above-named size was set down at 2 feet 3 inches. Sometimes the arrows were tipped with combustibles. The best makers of arrow-heads, as well as of bows, were compelled by law to go from town to town, to exercise their craft wherever it was most needed. The bowman usually carried 24 arrows, called a sheaf, or a quiver, at his right side or at his back; besides others in his girdle. He kept his bow in a case; hence Falstaff's comparison of Prince Hal to a bow-case, in allusion to his slenderness. Bowmen, in their hours of sport, used arrow-heads called *rigged*, *creased*, *shouldered*, and *spoon-headed*, according to the shape.

BOWIE-KNIFE.—A common hunting-knife used by Southwestern pioneers, and improved by Colonel James Bowie, who has been wrongly represented as a bully and a duelist. The bowie-knife is seldom concealed, and it is by no means the commonly used weapon which it is represented to be by foreigners; indeed, of late years it is seldom seen at all unless among hunters or settlers in the extreme frontiers.

BOWLINE.—A very useful knot, known as the single, running, and double bowline knot. The single bowline serves to throw over a post to haul on, also to sling a barrel; the running bowline, for securing paulins on ammunition-wagons; and the double bowline, for slinging a cask.

BOW-SHOT.—A term sometimes employed to denote the space which an arrow may pass over when shot from a bow.

BOWSING ROPE.—A rope used in the artillery service for moving a weight by simply hauling upon it.

BOW-STRING.—1. Great improvements have been made of late years in the strength of field-axletrees, rendered necessary by the increased strains. The

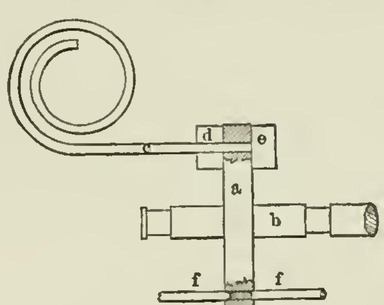
Bow-string.

wooden bed having been given up, the box-girder took its place, and the *bow-string* of steel is a further improvement. In this the bed is the top of a strong girder of deep section, the bottom of which is formed by the axletree; the latter is only pierced with holes for attachment to the bed at its thick ends. This arrangement prevents the thinner parts of the metal from being nipped or pierced when strained—an important matter, especially in dealing with steel. It is also easily taken off the bed when required.—2. On the quality of the bow-string depend in a great measure the shooting qualities of the bow. It should not be too thin, or it will not last long; in the selection of it, it is best to be guided by the size of the notch of the arrows. At one end of it a strong loop should be worked to go over the upper horn; the other end should be left free in order to be fixed on to the lower horn: this is done with a peculiar loop, shown in the drawing. When the lower end is fastened, the distance between it and the loop at the other end should be such, that when the loop is in its place (i.e., the bow strung) the string is, in a gentleman's bow, six inches, in a lady's, five inches, from the center of the bow. The string should be lapped for an inch above the nocking-point, and five inches below it, with waxed thread, and this again with floss-silk—to such a thickness that it completely fills the notch of the arrow, but without being too tight, or it may split it. Never trust a worn string; take it off and put on a new one—should it break, it will most probably snap the bow.—3. A string used by the Turks for strangling offenders.

BOWYER.—The military term for the man who makes or repairs the military bows. Not much used at present.

BOXER CARTRIDGE.—The Boxer cartridges for the Snider and Martini-Henry rifles are made on a large scale at the Woolwich Arsenal in what is known as the Small-arm Cartridge Department. Although the number of pieces constituting a Boxer cartridge is much greater than those on the American plan of drawing the shell out of a single disk of metal, the cost of manufacture is low, inasmuch as the parts are made very rapidly in presses tended by boys. The cost of a single small-arm cartridge at Woolwich is about one penny.

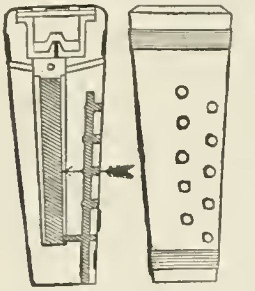
The bullets are made in presses of very strong and solid construction, the principles of which are shown in the accompanying drawing. The lead, hardened



by alloying it with one thirteenth of its weight of tin, is drawn out into wire which is wound on a reel, and from this reel it is fed into a revolving disk of hardened steel, *a*, which is pierced with round holes of the precise diameter of the finished bullet. This disk revolves vertically, and as it passes the sharp edge of a piece of steel, *d*, pressing against its side, the lead wire is shaved off, leaving in the die a quantity just sufficient to form the bullet. Revolving a little further, two punches, *f f*, press on the lead in the die from opposite directions, and give it proper shape at the point and base. In one of the punches there is a small hole for the escape of any surplus lead, if there chance to be any. There is a slight cannelure in the surface of the Martini-Henry bullet into which the mouth of the case is crimped to secure the bullet in its place in the cartridge. The bullets are rolled between a horizontally-revolving disk and a confining rim. The edge of the disk and inner surface of the rim have a raised rib, which make the required indentation or cannelure in the bullet.

The bullet for the altered Enfield rifle differs from the Martini-Henry bullet, inasmuch as it has two cavities and three cannelures. The cannelures are for holding the lubricants. The rear cavity has a clay plug in it for the purpose of expanding the lead, and the forward cavity is formed by a punch, and afterward closed over in a die. The object of this latter-named cavity is to give a proper adjustment to the position of the center of gravity of the bullet in firing. Small-arm ammunition in the British service is distributed in the field by means of carts designed for this service and drawn by two horses. Artillery ammunition is transported in wagons. See *Martini-Henry Rifle* and *Snider Rifle*.

BOXER FUSE.—A wooden-stock time-fuse. A coned composition channel is bored into the stock parallel to the axis, but one tenth of an inch distant from it. This channel receives the paper fuse-case. Just above the upper face of the fuse-composition is an unoccupied space from which four gas-vent channels lead to the outside of the stock above the point of the shell. Immediately above this gas-vent chamber the bore of the stock is considerably enlarged to receive the igniter. This consists of a small bronze hollow cylinder, closed at the lower end, where it is furnished on the inside with a pierced nipple for percussion-cap. The upper edge of the hollow cylinder is flanged in such a manner as to rest on the top of the stock; thereby preventing the igniter from being driven bodily into the fuse on discharge of the gun. Inside of this hollow cylinder the plunger is hung on a brittle wire (half copper and half lead).



When this arrangement is in place, the head of the fuse is covered with a piece of paper or linen luted down and shellacked. Thus far the fuse only burns for the full time for which it is pressed. In order to provide for intermediate times, two side channels are bored from the lower end of the fuse upward (one of these is shown in the drawing). Holes bored (at equal intervals) from the outside of the stock connect the exterior of the fuse with the side channels; the lowest communicating hole in each channel being bored entirely through to the fuse-composition. The channels are filled with mealed powder, and paper is pasted over the exterior of the communicating or time holes, which are arranged as shown in the drawing. The upper and lower ends of the stock are served with brass wire.

This fuse, which is virtually the English Boxer, works as follows: With a suitable tool pierce through the communicating hole, which corresponds to the number of seconds desired, into the column of fuse-composition (see arrow), then push the fuse by hand, giving it a slight twist, into the fuse-hole of the projectile, and load the gun. On the explosion of the charge the plunger, by its inertia, shears the brittle suspending-wire, and strikes the percussion-cap, which ignites the composition, and the fuse burns down to the point at which it was pierced. Then the flame flashes into the side channels, down the latter to the lower communicating hole, and thence to the bursting-charge. If for any reason the flame should not pass through the hole bored at the desired time, the fuse would still act at the end of its time of burning by igniting the charge through the lower communicating hole. If the shell strikes the object before sufficient time has elapsed to enable the composition to burn to the lower end, it is probable that the stock would be split and the whole be driven inwards; in which case it would act as a concussion-fuse. See *Fuse*.

BOXER LIFE-SAVING ROCKET.—The 12-pounder rocket used by the English Coast-guard Service is the invention of General Boxer, R.A. Three different patterns of these rockets have been made and issued. The one now in use is known as "Mark III." The Boxer rocket is composed of a head, head-clip, body, base-clip, base-plug, and diaphragm. The head is hemispherical in form, with a cylindrical tenon that fits in the front end of the rocket-case. The head-clip nearly envelops the front end of the rocket-case, with its forward edge coincident with the exterior junction of the case and head. On one side of the case the iron strap forming the head-clip is bent outwards to form a short rectangular tube, whose axis is parallel to that of the rocket. This short tube receives the front end of the rocket-stick. The body of this rocket consists of two cylinders of sheet metal (Bessemer). These cylinders are placed end to end with their axes coincident with the same straight line. The front cylinder is shorter than the other, to which and the inner diaphragm it is joined by screws passing through cases into the diaphragm. The front cylinder is filled with rocket-composition to within .4 inch of its front end. A conical-shaped cavity is left in the axial portion to furnish a large surface of inflammation. The rear cylinder is filled in a similar manner with composition, leaving a solid portion of this composition at the front end between the two cavities 1.2 inch in thickness. The cavity or "bore" of the rear cylinder is also conical in shape. The base-clip is analogous to that at the head, but is longer. It nearly surrounds the rear end of the rocket, and has a rectangular tubular projection on one side in line with that of the head-clip. The base-plug closes the rear end of the cylinder and is pierced with an axial vent one inch in diameter, through which the gas escapes after the ignition of the composition. The diaphragm is placed between and inside of the two body-cylinders, and performs the same functions for the front cylinder that the base-plug does for the rear one, and in addition serves as a seat for the assembling screws. A paper cap covers the vent, which must be broken before firing. The rocket-cases are protected on the inside from the action of the composition by a coat of anti-corrosive paint; the outside is protected and blackened by burning off oil. Since 1870 the exterior of the case is still further protected by two coats of red paint.

The following are the principal dimensions and weight of the rocket:

	Inches.	Centi-meters.
Total length	25.0	63.50
Radius of head	1.5	3.81
Diameter of rocket-case { Exterior	2.75	6.98
Diameter of rocket-case { Interior	2.6	6.6
Length of front cylinder	9.3	23.62
Length of rear cylinder	14.2	36.06
Head-clip { Length	1.5	3.81
Head-clip { Rectangular projection. { Width	1.3	3.30
Head-clip { Rectangular projection. { Depth	1.2	3.05
Base-clip { Length	2.5	6.35
Base-clip { Rectangular projection. { Width	1.5	3.81
Base-clip { Rectangular projection. { Depth	1.3	3.30
Length of clip-pin	*0.85	2.15
Diameter of vent	1.0	2.54
	Pounds.	Kilog'ms.
Weight of rocket	14.25	= 6.46

The rocket-sticks are made of pine and are 9 feet 6 inches in length. The portion of the stick that extends through the clips along one side of the rocket is square in cross-section, with a groove on the side next to the rocket to fit the curvature of the case. The stick in rear of the rocket is octagonal in cross-section. The lower end of the stick is surrounded by an iron ferrule. Two plates are placed, one at the upper end of the stick and the other at a distance from that end equal to the distance between the clips on the rocket. The lower plate has a small flange that brings up against the lower clip when the stick is inserted in position for firing; both plates are hollowed to fit the rocket-case. An iron clip-pin with the head bent at right angles is inserted in a hole through the stick in front of the base-clip, to prevent the withdrawal of

* Length of clip-pin before bending, 1.2 inch. Size of wire, No. 8 Birmington wire-gauge.

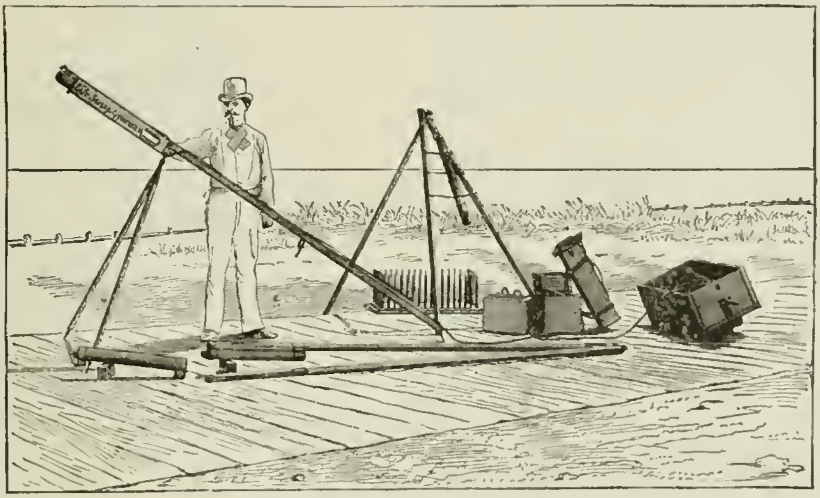
the stick in firing. The stick is partially surrounded for 18 inches below the vent by a sheathing of tin to protect it from the burning gases. Axial holes are bored in each end of the stick for the attachment of the line. These holes are curved outward from the axis until they reach the exterior of the stick on the same side. The holes are smoothed by passing a red-hot iron through them, charring the wood. The sticks are unpainted, and are packed in bundles of six each.

The stand for this rocket is known as the Boxer rocket machine or stand, "Mark IV." The material is sheet-iron, except the legs, which are of wood. This stand is lighter and simpler in construction than the older forms. The principal parts are an open rectangular trough or body, a curved trough, called by the English "a pry-pole," a horizontal axis, two legs, and a graduated arc made of brass. The rectangular trough or body receives the rocket. Its width is less than its depth. The front end is stiffened by a narrow iron strap around the outside. The upper edges are rolled over wire for the same purpose. Near the rear end, on each side, are cut subelliptical holes to admit the port-fire in firing the rocket. The body and pry-pole are connected by pieces of wrought-iron, rivets, and braces. There are two of the latter, one on each side. Two pieces of wrought-iron project from the rear end of the rectangular trough and have holes bored to receive the horizontal transverse axis. The long rounded trough or pry-pole extends into the rear end of the body for a short distance. The upper edges of the pry-pole are rolled over a large wire to stiffen them, and the trough is still further strengthened by a wrought-iron bar .5 inch thick, running along the bottom the whole length. The lower or rear end of this bar is decurved and pointed to form a ground-spike or foot. A strap with a buckle on the end is riveted to the pry-pole near the rear end, for the purpose of binding the legs to the pry-pole when they are folded up for transportation. The horizontal axis has a small swinging tablet below, through which are pierced two holes for rivets for the legs. The latter have a lateral motion upon these rivets as axes. The legs are made of tough wood. They have wrought-iron heads or sockets with slotted projections to embrace the tablet pendant from the horizontal axis. Ferrules envelop the lower ends, which are armed with pointed spikes in order to secure a firm hold in the soil when placed in position. On the right-hand side of the body, between the opening and the front end, is placed a sheet-brass quadrant, graduated and marked from 0° to 35°. The limits of elevation that can be obtained with this stand, due to its construction, are from 17°.5 to 40°. At the center of this arc is a rivet with a projecting head, around which is fastened a short string with a minute pear-shaped plumb-bob dependent.

The life-saving rocket-fuse is a frustum of a cone in shape, made of paper and covered with kamptulicon. It is 1.5 inch long and fits the vent in the base of the rocket, which is 1 inch in diameter. The fuse is covered with a paper cap tied on with twine. The bore of the fuse is filled with about an inch of ordinary fuse-composition, and burns about five seconds. The paper cap may or may not be removed before firing. The fuse is ignited by means of a port-fire.

The Boxer port-fire for life-saving apparatus has a total length of 9.3 inches, and is cylindrical in form. The exterior diameter of the case is .7 inch. One end is closed with a tin cap and a piece of kamptulicon; this cap is .5 inch long and .8 inch in exterior diameter. On one side the tin band of the cap is perforated to admit a detonating primer that enters a small space under the kamptulicon, and fires the priming of mealed powder. The exterior surface of the port-fire is painted flesh-color. A circular black spot on the cap indicates the position of the hole for the detonating primer. The time of burning of this port-fire is six minutes.

The following is the manner of using the Boxer or English life-saving rocket:



Boxer Life-saving Rocket.

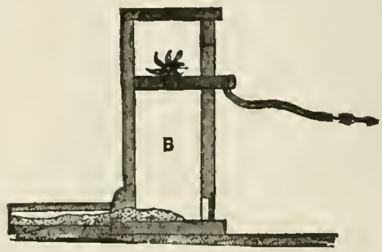
With the apparatus on the ground where it is to be used, place the rocket-stand in position, giving the necessary elevation by means of the graduated arc on the side of the trough and the plummet. Take a Boxer rocket, insert the stick through the clips, and drive in the clip-pin. Then wet about 12 feet of the end of the line and insert the end through the hole in the bottom of the rocket-stick, carry it along the stick to the hole near the upper end, draw it through and put on, first, a rubber washer and then a brass one, and tie a knot in the end, drawing the whole down snugly upon the end of the stick. It is better to tie a knot in the line after passing it through the hole in the rear end of the stick, so that in case the line burns off between the rocket and lower end of the stick the knot will catch and the line still be carried out. Remove the paper cap on the base of the rocket and insert a fuse. Place the rocket and stick in the trough of the stand, sliding them to the rear until the base of the rocket brings up against the front end of the curved trough or pry-pole. Put the faking-box, slightly inclined to the front, in rear of the stand and a little to one side. Insert a port-fire in the holder, and ignite it with a detonating primer. Advance to the stand, insert the port-fire in the opening on the side opposite to that on which the faking-box and line are placed, light the rocket-fuse, and retire towards the rear.

As soon as the rocket-composition is ignited and sufficient gas is evolved, the rocket starts, guided by the trough and the rocket-stick. After traversing a part of its trajectory, the composition in the rear cylinder is consumed, the solid part between the cylinders burns through and sets fire to the composition in the forward cylinder, giving a new impetus to the rocket and prolonging the range. See *Life-saving Rockets*.

BOXER SHRAPNEL SHELL.—This shell embodies the main features of the *Shrapnel*. The charge is placed in a chamber at the base, so that on explosion there is no tendency to increase the lateral spread of the bullets, but rather to increase their velocity and penetration. The shell has a cylindrical iron body, four longitudinal grooves inside, and is cast without a head. A tin case for the bursting-charge fits into the chamber, on the shoulder of which rests a wrought-iron disk. The shell is lined with paper and filled with balls imbedded in rosin. The balls for the smaller natures are of lead and antimony. A wrought-iron tube passes down the middle of the shell and through a hole in the center of the iron disk, to lead the flame from the fuse to the bursting-charge. The tube is tapped at the top to take a primer. A kamptulicon disk is placed over the bullets. The head is ogival in form and made of wood, covered with thin wrought-iron. The bursting-charge being confined in the tin case, the shell is not liable to premature explosion from pieces of iron breaking off the shoulder of the chamber by the shock of discharge. See *Projectiles* and *Shrapnel*.

BOXING.—Fighting with the fists. It was practiced as a manly exercise by the ancients, among whom it was an art so highly esteemed that Pollux, Hercules, and some of the other gods were represented as having excelled in it. The pugilists of the ancient games had leather thongs on their hands, sometimes loaded with lead or iron; this armature of the hand was called the *cæstus*. Of course their combats were not unfrequently attended with fatal consequences, which have resulted also in many instances of modern pugilistic encounters, although no armature of the fists is allowed. Among the Greeks the practice of boxing was at first permitted only to freemen, no slave or person attainted with crime being considered worthy to possess the high privilege of being beaten to the consistency of a jelly. Gradually, however, boxing was taken up as a profession, and its character deteriorated. Boxing was a favorite amusement of Englishmen for centuries; it is even said to have had such distinguished patrons as King Alfred and Richard III. But the golden age of pugilism as a profession in England commenced with the accession of the House of Hanover; then men calling themselves Professors publicly announced their intention of giving lessons in "the noble art of self-defense." One Professor challenged another to combat in the most bombastic language In 1726, one Ned Sutton, who announces himself as "Pipemaker from Gravesend, and Professor of the Noble Science of Defense," sneers at another Professor, whom he calls "the extolled Mr. Figg," for having by "sleeveless pretense" shirked a combat with him, "which I take," says the Pipemaker and Professor, "to be occasioned through fear of his having that glory eclipsed by me, wherewith the eyes of all spectators have been so much dazzled." He further assures the said Figg that if he can muster courage enough to fight with him, he (Figg) "will have the advantage of being overcome by a hero indeed!" Figg had an "amphitheater" in Oxford Road, wherein fights were held; and a larger one was erected in the same locality in 1742 for one Broughton, the funds being subscribed by some eighty noblemen and gentlemen. The pugilistic encounters that took place here were patronized by many of the nobility. Some faint protests against the brutality of the pastime now began to be made by the press, but these had little effect. Towards the end of the last century fights were patronized by Princes of the Blood Royal; and the Prince of Wales, afterwards George IV., was present at one at Brighton in which one of the combatants was killed. When the allied Sovereigns and their Generals went over to England in 1814, Lord Lowther treated them to a series of boxing-matches in his drawing-room, which were so highly relished that they were repeated a few days afterwards. One of the pugilists, called Jackson, became quite a hero, and made enormous sums by giving lessons to young noblemen, among whom was Lord Byron. In 1817 the Czar Nicholas of Russia witnessed a prize-fight at Coombe Warren. At the close the victor was presented to him, with whom he shook hands. This was the last time that Royalty was present at one of these disgusting spectacles.

BOX-TRAP.—A common method of firing mines is by the use of the *box-trap*. This is a box 18 inches high and 6 inches wide in the clear. The bottom consists of a piece of plank 18 by 10 inches, and its cover is fixed at one side only with a wooden pin, about which it can be turned. At 6 inches from the top of the box a horizontal slit is made in one of its sides, and grooves in the two adjacent to it, to receive



a piece of board, which ought to slide freely in this arrangement. In the lower part of the box an opening is left on the side opposite the one cut for the slide, to admit the powder-hose. To fire the train, place the box against the extremity of the tamping and secure it well; tie a string to the slide and lead it along the stanchions of the gallery on pegs driven for that purpose; put the end of the hose into the box through the hole left for it, and spread on the top of it some dry, fine powder; then put in the slide and close with earth or rags of sand-bags all communication between the lower part of the box and the branch; place a star-match of six or eight points, well lighted, on the slide; replace the cover, then pull the string, and the star will fall below and fire the mine. See *Monk* and *Rocket-trough*.

BOYAUX.—In military engineering, winding or zigzag approaches dug to form a path or communication between the different armed trenches of a siege-work, and to prevent them from being enfiladed or fired upon in flank. Each branch of an approach overlaps that behind it by about ten yards, to afford protection against enfilade, and to serve as a trench depot for trench-materials. The dimensions may be the same as those used in the first parallel, and frequently these are adopted if there is to be much use made of the approach. In both the parallel and the boyau it is recommended to slope the bottom of the trench to the rear, giving a fall of about six inches. This provides for drainage, and also affords greater protection to the men using them. See *Siege*.

BRABANCONS.—Mercenary fighters from Brabant and other countries who, in the later Middle Ages, served any who would pay them. They were poorly organized and little better than banditti.

BRACELET.—An ornament worn on the arm, generally at the wrist. Bracelets and armlets have been used by every nation, both savage and civilized, from the earliest periods to our own. They are frequently mentioned in Genesis as worn both by men and by women, both by the Hebrews and the surrounding nations. Similar ornaments were worn round the ankles, but they are stigmatized by Isaiah as marks of luxury (iii. 16). The Medes and Persians were remarkable, even amongst Asiatics, for their love for ornaments of this class. They wore not only bracelets and armlets, but ear-rings, collars, and necklaces, which often consisted of strings of valuable pearls or were enriched with other jewels. These ornaments were used to indicate the rank of the wearer, and this use has continued to be made of them in the East down to the present day. In Europe, bracelets and armlets were worn both by the classical nations and barbarians from the earliest times. The Gauls wore them; and the Sabines, as early as the foundation of Rome, had ponderous golden armlets on the left arm. The same was the case with the Samians about the same period. It does not appear that armlets were worn by men during the historical period of Greece, but ladies wore both armlets and bracelets of the most various materials and forms. Both generally passed round the arm several times, and the form of bracelet now most in fashion has been accurately copied from those twisted spirals described by Homer in the eighteenth book of the *Iliad*. Many examples of this kind of bracelet, as represented on painted vases, will be found in Sir William Hamilton's work. We are indebted to the Greeks even for the idea of giving to these spiral bracelets the form of a snake, the best models of our present goldsmiths being exact copies of antique bracelets. The goddesses of the Greeks, like the blessed Virgin in Roman Catholic countries, were represented as attired in the style of ladies of the highest rank; and the celebrated marble statue of Aphrodite, preserved at Florence, exhibits traces of a metallic armlet. Amongst the Romans, armlets were frequently conferred upon soldiers for deeds of valor, of which an instance is mentioned by Livy (x. 44). Roman ladies wore bracelets, not only for ornament, but also for the purpose of containing amulets, which were supposed to effect miraculous cures. On this principle it is said that the Emperor Nero wore on his right arm the skin of a serpent, inclosed in a golden armilla. But at Rome, also, it was chiefly as an indication of rank or wealth that these ornaments were worn.

BRACKETS.—In artillery, the cheeks or sides of ordnance-carriages. Carriages termed "bracket-trail," in contradistinction to the "block-trail" pattern, have been introduced into the English service; all the new field- and some of the siege-carriages have been made of this pattern.

BRACKET-TRAIL.—The body of the *bracket-trail carriage* consisted of two brackets, connected together by three transoms, the trail thus formed being termed a *bracket-trail*. The length of the transoms varied according to the nature of the gun, and there were two sets of trunnion-holes.

BRACONNIERE.—In antiquity, a mail armor, of the shape of a petticoat, which was attached to the cuirass, and reached from the hips to the middle of the thigh, and sometimes below the knee. Also written *Bragonnière*.

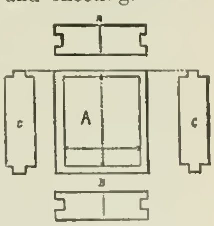
BRAKE.—A contrivance to stop motion by friction, applied mainly to wheels and hoisting apparatus. Originally it was a flexible iron band so placed that it might be drawn tightly around most of the outer surface of the revolving wheel, the friction gradually slackening the motion. In carriages curved blocks of wood were used, and pressed against the tire by a lever worked with the hand or the foot. Modern invention has given us systems of brakes that may be instantly applied to every wheel in a train of cars. For the Creamer brake, once somewhat in favor, a powerful spiral spring was the power applied. This spring was coiled in a drum through which a shaft passes, and was set free by the brakeman, or all the brakes on a train could be set free by one act of the engineer. The Westinghouse air-brake is now very generally used in America. Each carriage has beneath its floor a cylinder and piston which may be operated by compressed air; the piston acts on suitable levers and rods to set the brakes against the wheels, the brakes being also connected with the ordinary braking mechanism at the platform of the cars. Compressed air is conveyed to the cylinders by tubes leading from a reservoir at the locomotive, and this reservoir is filled by a special engine which is independent of the ordinary motive mechanism. The special engine acts automatically, starting when the pressure of air in the reservoir is below a fixed standard, and stopping when the pressure reaches another fixed standard. The engine-driver communicates the compressed air to the cylinders by the simple act of turning a valve-handle through one fourth of a circumference; the brakes are instantly "set" with great force throughout the train. A different system uses a vacuum, and the pistons beneath the cars are acted on by atmospheric pressure, when the cylinders are in communication with the vacuous reservoir. The Westinghouse and the other air-brakes serve to place the train very fully under the control of the engine-driver; permitting the stoppage of trains from high speed in a very short space. See *Pneumatic Gun-carriage*.

BRAN.—The material obtained from the outer covering or husk of grain during the process of grinding, and which is separated from the finer flour before the latter is made into bread. It is generally met with in commerce in thin scaly yellowish-brown particles, with sharp edges, and its composition in 100 parts is as follows:

Water	13.1
Albumen (coagulated)	19.3
Oil	4.7
Husk, with a little starch	55.6
Ash or saline matter	7.3
	100.0

Bread made of flour containing bran is known as *brown bread*. The main uses to which bran is put are in the feeding of horses and stock, and in clearing and brightening goods during the processes of dyeing. In the practice of medicine, bran is employed as a warm poultice in abdominal inflammation, spasms, etc., and an infusion is used as an emollient foot-bath. It is also used internally in catarrhal affections.

BRANCH GALLERIES WITH DUTCH CASES.—These galleries are of the same dimensions as small branches. The frames are made of thick plank, and are placed in the branch galleries touching each other, serving both as frames and sheeting. Each case consists of four pieces; the stanchions have a tenon at each end, fitting into notches cut in the cap and ground sills to receive them. When the gallery is an ascending or descending one, the ends of the stanchions may be cut obliquely, in order that their sides may always be vertical; or the ordinary cases may be set so as to be perpendicular to the gallery floor. For the purpose of limiting the explosive effects of mines upon the branches leading to them, and at the same time enabling the miner, acting on the defense, to push forward and open a new branch towards the crater, a portion of a branch leading towards the mine is made of heavy frames of the foregoing construction. The timber recommended for the purpose is oak, and the pieces of each frame are 12 inches wide and 4 inches thick. The portion of this strong framework, at the extremity, is solidly filled in with pieces of 4-inch scantling, from 6 to 10 feet in length. For a branch 28 inches high and 24 inches wide seven



Elevation, A. and pieces of frame of Dutch Case.

horizontal layers will be required, each layer consisting of 6 pieces. The center piece of each layer may have a rope handle at its end to allow of its being drawn out readily. Filled in this way and having earth well packed between the pieces, branches of this description will not be damaged by the explosion of mines of from 6 to 10 feet line of least resistance even when the mines are within 4½ to 6 feet of the branch. From their chief object these branches are termed by the French *rameaux de combat*. See *Gallery*.

BRAND.—The old Anglo-Saxon term for burnished swords of all descriptions.

BRANDING.—A mode of punishment practiced in England for various offenses. It was effected by the application of a hot iron, the end of which had the form which it was desired should be left imprinted on the skin. But branding by such means has long ceased, and now it is practically confined to the case of desertion from the army; the branding or marking being not done by a hot iron, but with ink or other similar preparation. By the Mutiny Act of 1858 it is enacted as follows: "On the first and on every subsequent conviction for desertion, the Court-Martial, in addition to any other punishment, may order the offender to be marked on the left side, two inches below the armpit, with the letter D, such letter not to be less than an inch long, and to be marked upon the skin with some ink or gunpowder, or other preparation, so as to be visible and conspicuous, and not liable to be obliterated." Formerly branding was employed in the case of all *clergiable* offenses by burning on the hand; and, with a view still further to repress theft and petty larceny, it was enacted that such offenders as were allowed the benefit of clergy should be "*burnt in the most visible part of the left cheek, nearest the nose.*" This additional severity, however, not having the desired deterrent effect, but the reverse, was repealed by an Act which nevertheless provided for offenders being burnt on the hand as formerly. The latter punishment, however, was entirely abolished by an Act passed in 1822. Brawling in church was made an offense punishable by having one of the ears cut off, or, the offender having no ears, by branding with the letter F on the cheek.

BRANDSCHWAERMER.—A small rocket which contains a bullet. It is fired out of a gun, and used for the purpose of setting fire to straw-thatched buildings.

BRAQUEMARD.—A comparatively short weapon of the sixteenth century. It held a place midway between a sword and a dagger, had a straight flat wide blade, very sharp at either edge, and pointed. It had on the hilt a cross-guard that curved on both sides towards the point of the weapon.

BRAQUEMART.—1. A short sword of Italian origin, used in the fifteenth century, and very much like the *anelace*. 2. In antiquity, a two-edged broad-sword. Also written *Jacquemart*. See *Braquemard*.

BRASS.—An alloy of copper and zinc, largely used for ordnance purposes, certain parts of machinery, and other ornamental and useful articles. Technically the term *brass* is extended so as to include compounds of copper and tin, as in *brass-ordnance*, the *brasses* or bearings of machinery, etc.; but such alloys of copper and tin, though styled *hard brass*, are more strictly varieties of bronze, and the present notice will be confined to the alloys of copper and zinc, or *yellow* brass. In ancient history, Biblical and profane, frequent allusions are made to the employment of brass in the construction of musical instruments, vessels, implements, ornaments, and even gates; but as no mention is made of its mode of manufacture, or even of its composition, it is doubtful if the brass of the ancients was composed of copper and zinc. In the manufacture of brass on the large scale, two parts by weight of copper to one part of zinc are used, the zinc being one half the weight of the copper; but alloys are made for particular purposes with less or greater proportions of zinc. Thus, where a material of more than ordinary tenacity is required, the zinc is reduced to one fourth the weight of the copper; and where an alloy of a hard and brittle nature, possessing little resisting power, is wished for, the zinc is increased to an amount equal with the copper, or greater. In the manufacture of brass either of two processes may be followed. The direct method is to fuse the zinc in a crucible, and gradually add the copper in pieces. But this process is attended with disadvantage, owing to the volatile and oxidizable nature of zinc. The indirect method of forming brass is that which is generally followed in England and elsewhere, and consists in heating in crucibles or pots a mixture of calamine (carbonate of zinc, $ZnOCO_2$), charcoal, and thin pieces of scrap or grain copper. The calamine is generally first calcined or roasted, so as to expel any traces of sulphur, then mixed with one fourth of its weight of charcoal, and this mixture introduced into the crucible, after which the metallic copper is diffused through the mixture by being beaten in with hammers or mallets. The proportions employed are 3 parts of the mixture of calamine and charcoal to 2 parts of copper; and when introduced into a furnace, and subjected for 5 to 24 hours to the action of a white heat, the charcoal reduces the calamine and separates the zinc, which, combining with the copper, forms 3 parts of brass, containing about 2 of copper to 1 of zinc. For ordinary purposes brass is first cast into plates of about 100 pounds weight, and ¼ to ½ inch thick, which can be readily broken up, remelted, and cast in a mold of any desirable shape or size. The crude casting so obtained is generally screwed to a turning-lathe, and turned and bored into the required form with iron tools.

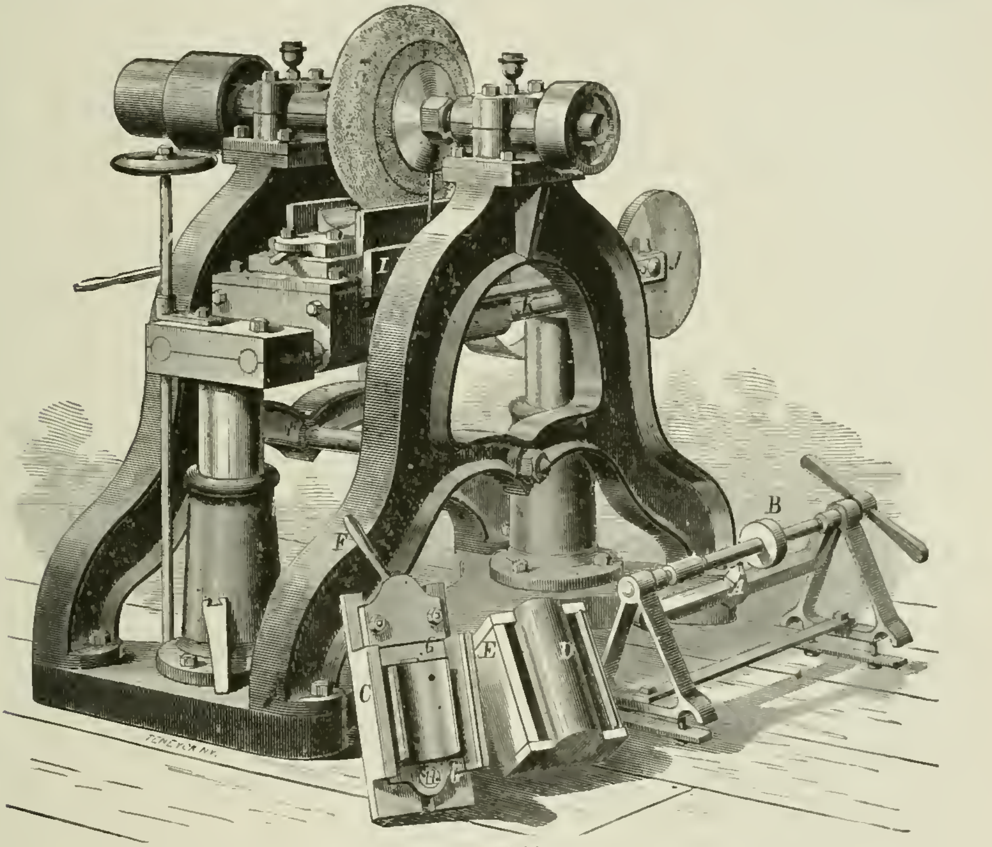
BRASSARDS—BRASSARTS.—The name of the pieces which, in plate-armor, protected the upper part of the arms, and united the shoulder and elbow pieces. *Brachiale* was the ancient name for brassards. When the front of the arm only was shielded, the pieces were called demi-brassards. Brassards or armlets, made of cloth, and worn on the arm, are now used as a badge of recognition by the *personnel* and all members of the military and international ambulances in time of war. The color of the cloth is white, with a red cross woven on it, which is the emblem of the Society for the Help of the Sick and Wounded. The armlets are issued on the commencement of hostilities by the Central Committee of that Society, and duly stamped and numbered, so as to prevent fraud. The term *brassar* is also applied to a piece of defensive armor for the arm.

BRASSET.—A casque or head-piece of armor much worn in ancient times.

BRASS-FITTING MACHINE.—The use of brasses entirely unfitted and rough from the sand results in great wear of material and of the brasses, in hot brasses and the accidents entailed thereby, in an immense consumption of oil, and in such excessive friction as greatly to increase the power necessary to draw the train. The ordinary method of fitting brasses is by the use of the lathe and file, and the work requires the labor of a skilled mechanic.

The machine represented in the drawing has not only superseded the above-named tools for the purpose, in all well-equipped arsenals, but has also rendered the accurate fitting of brasses a cheap process, requiring no particular experience or skill. The principal feature of the apparatus is found in the emery-wheels, which are originally turned and then kept true by a patented diamond tool, the latter being so arranged that it is impossible to turn by it anything except the geometrically correct circle to which the master-mechanic sets it. Wheels of 20 inches diameter are used; and though they should be worn down to the flange, it is claimed that they will still grind the full diameter desired, while a speed of from 1080 to 1800 revolutions is all that is required.

The diamond tool, A, is shown in its frame, in the engraving, detached from the apparatus proper. The tool, it will be observed, swings on a center in its frame, and can be adjusted to any arc. Once set, it can only turn the prescribed arc with accuracy. In order to avoid the necessity of the foreman having to set the tool, a gauge is also furnished. This consists of a spindle adjustable with a nut in such a way that its two points rest in the centers on which the diamond tool revolves. It is only necessary for the disk, B, turned accurately to the diameter of the bearing, to be prepared, and this the apprentice can place on the spindle, adjust the latter, and screw down the diamond tool until it touches the periphery of the disk. A nut is then fastened on the diamond tool, and the frame is lifted on the ways beneath the wheel, when the moving of the handle turns the face of the wheel to the exact circle desired.



Brass-fitting Machine.

To adjust the brass in the chuck, C, it is first set on the axle, D. The chuck is then placed on frame, E, in such a way that the V's fit. Handle F then moves a cam that clamps the brass between the jaws, G, one set of which swing on a pivot at H. The brass is thus adjusted in such a manner that, despite the imperfections in molding, it is ground accurately with the least removal of metal. The chuck, C, fits into planed guides on the table, I, and is thus brought in exact line with the motion of the wheel. The crank, J, serves to move the table to and fro on the rods, K, and the table also rises and falls on planed ways, being pressed up by springs. The hand-wheel gives vertical adjustment to the whole bed by means of a chain beneath it. There is a pulley by which a suction-fan, to remove dust, etc., may be driven. The machine is claimed to be capable of fitting from 150 to 500 brasses per day. See *Emery-grinder*.

BRATTICE—BRETTICE.—A vertical wall of separation in a mining-shaft which permits ascending and descending currents to traverse the respective compartments, or permits one to be an up-cast or downcast shaft, and the other a hoisting shaft.

BRAVI.—Those individuals in Italy, but especially in Venice, who undertook to perform any dangerous deeds for money. It is now employed chiefly to designate hired assassins. The Italians also gave the name of *Bravi* to those fanatics in the Turkish army who, after maddening themselves by opium, rushed upon the ranks of the enemy, and so met death.

BRAY.—A tower or block-house in the outworks of a fortification before the port.

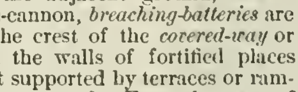
BRAYETTE.—That part of the armor which covered the abdomen. It was composed of steel plates, and ended in the tassets.

BRAZING.—The laboratory process of uniting together two pieces of brass, two pieces of copper, or one of each, by means of a hard solder partaking more or less of the composition and properties of ordinary *brass*. The edges or parts of metal to be joined are first filed bright, so as to be thoroughly clean, then there is strewed over the gap or crevice a mixture of the solder and borax. The solder employed varies in composition according to the kind of work, and may be rendered more fusible by the addition of a larger amount of zinc, but the general proportions are (1) 16 copper, 16 zinc, and 1 tin; (2) 12 brass, 4 zinc, and 3 tin; or (3) 18 brass, 3 zinc, and 2 tin. When the whole has been fused together, it is allowed to cool, and is then filed down to a coarse powder, in which state it is used. The borax is employed to form a glaze over the brightened surfaces, and thus prevent the oxidation of the metal, which would seriously interfere with brazing, and even stop the operation. An outward coating or layer of charcoal is likewise serviceable in the exclusion of the air during the brazing of large pieces of metal. Where a very high heat is required in the process, a little powdered glass is mixed with the borax. The mixture of solder and borax may be applied dry, but it is better to moisten it with water and to lay it on the filed surfaces with a spoon. The whole is then gently heated, when the water evaporates and leaves a crust of borax and solder. The work may now be strongly heated before the blow-pipe, or over a clear fire, and at a bright red heat the solder fuses and the zinc begins to burn with a pale blue flame. At this stage the solder *flushes* or becomes liquid enough to permeate the joint or crevice; but should it be tardy in acting thus, several slight taps will insure the proper result. The whole is now cooled, and, towards the close, the articles may be introduced into cold water for more rapid reduction in temperature. Pieces of metal which have undergone the process of brazing are so firmly united that they may be rolled and re-rolled without the parts yielding.

BREACH-BATTERIES.—Exposed revetments of masonry may be breached by heavy smooth-bore guns, at ranges from 400 to 600 yards, and batteries thrown up in such cases are in all respects like those for enfilading or counter-battering. When the revetments are covered from distant fire by an earthen mask, the breach-batteries must be placed on the borders of the ditch, either on the glacis or on the terre-pleins of the defenses, at points where no obstruction will intervene to prevent the fire of the guns from being directed at a point of the wall to be opened low enough to form a breach which shall be practicable to the ascent of an assaulting column. The results of the recent seiges of Forts Pulaski and Wagner are conclusive upon the question of the vulnerability of the best masonry to rifled projectiles at long ranges. The former work was breached with 30-pounder rifles at about 1700 yards, and General Gillmore, in his report, expresses the opinion that the best-constructed brick revetments can be breached with satisfactory rapidity at ranges of 2500 yards. The range of the batteries of 8- and 10-inch Parrott guns against Fort Sumter was from 3500 to over 4000 yards, from which every vulnerable part of this work that could be reached from the batteries was laid in ruins. The effect of these projectiles fired with long ranges under great angles of elevation, upon scarps covered by earthen masks placed some distance in advance of the scarps, cannot fail to be productive of much damage wherever the projectile attains the scarp, although, from the uncertainty of the fire on a hidden object, breaching under such circumstances will seldom be resorted to owing to the length of time and expenditure of ammunition that would necessarily be required to make a practicable breach in the work. These batteries must be sunk when placed on the borders of the ditches, the level chosen for the platforms being such as to subserve the object in view. The embrasures in these cases are usually cut out of the parapet, as an ordinary trench has generally to be first established as a preparatory step to commencing the battery. The forms and dimensions adopted for other sunken batteries will apply to these cases, with such modifications as may be demanded by the site of the battery, the field of fire, and the position of the point to be attained by the fire.

When a breach-battery is established either on the glacis or upon the terre-plein of a work, its guns will generally be exposed both on their flank and rear to the fire of dangerous commanding points, from which it will be necessary to cover them by traverses. The number of traverses and their position will depend upon the command and position of the dangerous points. To cover from the flank fire, if the command of the dangerous point is considerable, like that of a cavalier within the enceinte of the besieged, it may be necessary to place a traverse between every two guns, or even between each gun. The traverses used in such cases receive a thickness of fourteen feet, or seven gabions, like those for covering an ordinary trench from an enfilading fire; their length will depend upon the relative positions of the dangerous point and the exterior point of the battery to be covered; their height is usually not greater than the traverses for the ordinary trenches that serve only as communications. When the reverse of the battery is exposed it will generally arise from the salient position of some comparatively distant point, from which a slant fire may be brought to bear on this part of the battery; in which case it will generally be easy to cover the part exposed by running out, from the reverse of the battery, an end of trench, to form a wing traverse that shall intersect the lines of fire of the dangerous point upon every part exposed. The guns of breach-batteries should be so placed that the direction of their fire may be as nearly perpendicular as practicable to the line of wall to be breached; and where these lines are oblique to each other, the obliquity should not exceed 45°, otherwise the effect of the shot will be greatly diminished and the operation retarded. Besides the breach-batteries, it may be necessary to place counter-batteries on the glacis. Their object will be to counter-batter and silence the artillery of those portions of the defenses which can be brought to bear on the breach-batteries, or on the passages of the ditches. These counter-batteries will usually be so placed as to fire along the ditches of the defenses. Their arrangement, in all respects, will be the same as that of the breach-batteries. See *Batteries*.

BREACHING.—Escalade being ordinarily very difficult, particularly when the besieged are aware of the intention of the besiegers, the latter are generally compelled to destroy a portion of the face of the work to obtain an entrance. Such an opening is called a *breach;* and to effect it with artillery, particularly in a well-constructed work, where no part of the scarp-wall is visible from the adjacent ground, within effective range of siege-cannon, *breaching-batteries* are established either on the crest of the *covered-way* or on the *glacis*. When the walls of fortified places were very high and not supported by terraces or ramparts, stone projectiles were used. From the want of sufficient hardness in these projectiles, the besiegers were forced to commence battering at the top of the wall where the least resistance was offered, and gradually to lower the shot until the breach reached the wrecks already formed at the base of the wall. When the style of fortification was changed, this operation became very laborious, the ascent was very steep, and the breach was often impracticable. This method was abandoned and mining substituted. Iron projectiles superseded stone, and then a more rapid mode of effecting a practicable breach was suggested and confirmed by experience. Vauban recommended increasing the size of the hole first formed, by continually firing at its sides until the wall should fall; but the ball was found to glance into it and injure but slightly the untouched portion of the revetment. The best mode, however, as found by experiment, is to cut the wall up into detached parts, by making one horizontal and several vertical fissures, and *battering* each part down separately, as indicated in the drawing. The easiest manner of making the cut is to direct the shots upon the same line, and thus form a series of holes, somewhat greater than a diameter apart, and then to fire a second series of shots, directed at the several intervals between the first, and so on, until an opening is made completely through the wall.



The first cut is made horizontally, and finished, which will be known by the earth falling through it; the vertical cuts are then made, there being one at each end of the intended breach. These cuts are commenced at the horizontal cut, and raised until the wall, isolated from its supports, sinks, overturns, and breaks into pieces, which become covered by falling earth. If the earth be sustained by its tenacity, loaded shells are fired into it, which, acting like small mines, cause it to fall, and make the breach *practicable*, or of easy ascent. If the portion of the wall between the vertical cuts should not be overthrown by the pressure of the earth behind, it must be detached by a few volleys of solid shot, fired at its center. This will speedily bring it down in a mass. The moment the wall is down and the parapet destroyed, the breach will be as perfect and the slope as easy of ascent as it can be made by the fire of the batteries. It is important to determine the height of the horizontal cut above the bottom of the ditch, for, if this height be not properly chosen, the breach may be difficult if not impracticable. If too high, the ramp composed of the débris will be intercepted by a portion of the wall; if too low, the opening will be masked by the débris and the formation of the cut impeded. The most suitable height is nearly equal to the thickness of the wall where the cut is established. The thickness, where not known, can be deduced from the dimensions necessary to be given to the wall, to resist the pressure of the earth of the rampart and parapet. The time necessary to make a breach depends on the size of the breach to be made, the material of the scarp, the number of guns, etc. For a breach of 20 to 30 yards in length, at 40 yards from the battery, 1500 shot of large caliber will be required; but when the battery is at a greater distance, a greater number of projectiles will be necessary on account of the diminished accuracy and penetration. Thus, at 500 or 600 yards 9000 to 10,000 may be needed. See *Effects of Projectiles, Penetration*, and *Projectiles*.

BREACH-KNIFE.—A weapon used as late as the eighteenth century. It was especially common in Austria and in other parts of Germany, but in reality it was nothing but a *scythe-knife*.

BREACH OF ARREST.—A crime usually punishable with cashiering. The Articles of War provide that officers charged with crime shall be arrested and confined in their barracks, quarters, or tents, and deprived of their swords by the Commanding Officer. And any officer who leaves his confinement before he is set at liberty by his Commanding Officer shall be dismissed from the service.

BREAD.—In camps and in barracks of any size in England the bread for the army is baked on the spot by bakers of the Supply Sub-department of Control Organization. Though perhaps a little rough in its manufacture, the article supplied is made from the best ingredients, and is genuine and wholesome. On a march, the Control Bakeries supply bread at the several halting-places. In smaller barracks, bread has to be obtained by contract, but the most vigorous supervision is exercised to secure proper quality. Formerly army-bread was notoriously bad. A contractor would sometimes send in a tender so low, in order to obtain the contract, that he could not possibly make good bread at a profit; and then he relied on small fees paid him by the soldiers as a means of obtaining better. This discreditable state of things was ascertained by a Committee of Inquiry some years ago; it was found that the average of army bread was not equal in quality to that of work-house bread. Steps were forthwith taken to remedy the evil; experiments were made to determine whether troops could bake their own bread in the field, and the result was the adoption of the present system of army baking. With the improvement of the bread a visible amelioration in the health of the soldiers has taken place. In the United States army the troops do the baking both in barracks and in the field.

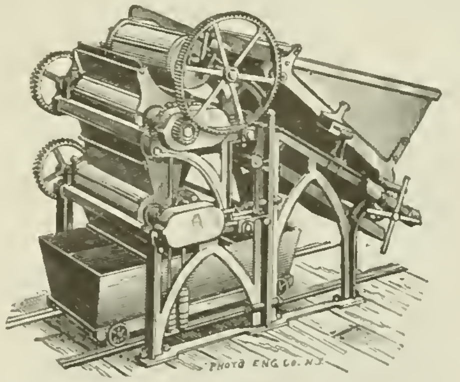
BREAD AND WATER.—The diet of prisoners and parties under charge of the guard. An authorized military punishment.

BREAK.—1. A change from the general direction of the *curtain* of a fortification near its extremity, in the construction with orillons and retired flanks. 2. A commutator or apparatus to interrupt or change the direction of electric currents.

BREAKER.—A cup-shaped covering, usually made of lead, which serves to break a tube of glass or plaster of Paris at the proper time for igniting the charge in fuses of certain construction. See *Prussian Fuse*.

BREAKING-DIAMETER.—The diameter of a piece at the instant of rupture may be called its "breaking-diameter." This would remain the same for the tangential strain; but if we consider the transverse strain only, this diameter increases with the length of stave. For a certain length of stave under pressure, say two or three calibers, the breaking-diameter due to the transverse strain would be the same as the breaking-diameter for the tangential. In this case there would be a tendency to rupture both tangentially and transversely, and the resistance of the metal would be called fully into play in both directions. For greater length of staves the breaking-diameter due to transverse strain would be greater than that due to the tangential, and the piece would rupture tangentially before reaching its transverse "breaking-diameter," and therefore the transverse resistance would not be called fully into play. For shorter staves the reverse would be the case.

BREAKING-DOWN MACHINE.—The powder, having been incorporated, is taken from the mills in open tubs and placed in small magazines, where it is allowed to remain for a day, in order to give the viewer time to examine the quality of the cake, and to compare the production of one mill with that of another, for it is found that that part of the charge which has been subjected to the last few revolutions of the runners is generally a little drier than the rest; therefore allowing the whole to remain exposed for a short time tends to equalize the moisture, from two to three per cent of which greatly assists the operation of pressing. The incorporated powder, in the condition of soft cake, has now to be broken up into pieces of a uniform size, so that the spaces between



Breaking-down Machine.

the plates in the press-box (hereafter described) may be equally filled and the powder subjected to the same amount of pressure over its whole surface. Reducing the mill-cake to meal of a uniform size also assists in mixing any portions that may be more dense than others, due to their having been under the runners and receiving the full effect of the incorporating operation up to the last.

The breaking down of the mill-cake is effected by the breaking-down machine, which consists of two gun-metal side frames, supporting two pairs of gun-metal rollers, the one pair being immediately under the other. These rollers are 7¼ inches in diameter, and have a total length for operating upon the cake of 2 feet 6 inches. The surfaces of the upper pair have grooves of 1.05 inch pitch, cut longitudinally upon them to a depth of ¼ inch. These rollers work at a speed of twenty-five revolutions per minute, and motion is imparted to them by means of a main driving-shaft and spur-gearing connected with the motive power. The back roller of each pair works in a sliding bearing, and is pressed forward to its opposite roller and kept up to its work by means of weighted levers. This is a safety arrangement, and is provided in order to admit of the rollers opening to allow any large quantity of the cake, a hard lump, or any foreign substance, to pass freely through them, thus preventing injury to the machinery, and possibly an explosion. There is also a scraper attached to each pair of rollers for removing from them as they revolve any powder that may adhere to their surfaces.

To prevent the dust spreading about the building when the machine is at work, the rollers are inclosed in sheet copper and gun-metal casings; these also act as spouts, and guide the meal into the boxes placed underneath the machine for its reception.

The working of the machine may be described as follows: The incorporated mill-cake is brought from the magazines, and placed in a wooden hopper that holds about 700 lbs. Underneath the open side of this hopper works an endless band of strong canvas, having strips of leather stitched across it at 4 inches apart. This band passes over two drums, the upper one being driven from the gearing of the machine, so that when in operation this band revolves, and carries a portion of the mill-cake with it from the hopper, and discharges it over the upper drum between the first and uppermost pair of rollers. After being crushed and passing through these, it falls into the second pair immediately underneath, where it is further crushed or broken up into pieces of the required size. From these it falls into the spout, and is conveyed to the boxes placed underneath for its reception.

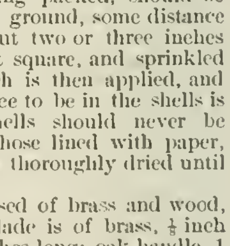
When the hopper has been filled with mill-cake, the attendant retires to a place of safety, and then sets the machine in motion. After working for about half an hour—which is sufficient time to break down an entire charge of 700 lbs.—he, from his place of retreat, stops the machine, and, after waiting for a few minutes, enters the house, empties the boxes, and removes the powder before refilling the hopper. The meal, as it is taken from the boxes, is conveyed in tubs, and placed in other small magazines, from whence it is taken as required to the press-house for the purpose of undergoing the next process. All these dangerous operations are carried on in separate buildings, well removed from each other; and, as a matter of precaution, the machine is entirely constructed of gun-metal and wood, excepting the shafts, which are of wrought-iron encased in copper. See *Gunpowder*.

BREAKING GROUND.—In military operations, the first excavation of the earth to form intrenchments, as at the commencement of a siege. It is applied also to the striking of tents, and quitting the ground on which troops have been encamped.

BREAKING ON THE WHEEL.—A very barbarous mode of inflicting the punishment of death, formerly in use in France and Germany, where the criminal was placed on a carriage-wheel, with his arms and legs extended along the spokes, and the wheel being turned round, the executioner fractured his limbs by successive blows with an iron bar, which were repeated till death ensued. There was considerable variety in the mode in which this punishment was inflicted, at different times and in different places. By way of terminating sooner the sufferings of the victim, the executioner was sometimes permitted to deal two or three severe blows on the chest or stomach, known as *coups de grâce;* and occasionally, in France at least, the sentence contained a provision that the criminal was to be strangled after the first or second blow. Mercy of this kind was, however, not always allowed to be shown to the victims of the wheel; when Patkul, the envoy of Peter the Great, was put to death on the wheel by order of Charles XII. of Sweden, it is said that the officer in command of the guard was cashiered by the Swedish king in consequence of having allowed the head to be struck off before life was extinct in the mangled limbs. The punishment of the wheel was abolished in France at the Revolution; in Germany it has been occasionally inflicted during the present century, on persons convicted of treason and parricide.

BREAKING UP AMMUNITION.—In breaking up small-arm ammunition, the tables should be arranged against the sides of the room, and in front of them, on the floor, boards one foot wide are secured on edge, so as to leave a space of three feet between them and the tables, inside of which the workmen stand and the scrap paper is thrown. By these means the center of the floor remains clear, and should be kept wet. Each workman should be provided with small wooden boxes or copper pans, one for powder, one for caps, and one for bullets. The tables should be kept as clean as possible, counter-brushes being provided for that purpose. A square copper box, with screw top and a capacity of about 100 pounds of powder, is placed at one side of the room; into this the men empty the powder obtained; a large copper funnel, 18 inches wide at the top, is used to prevent the powder from spilling on the floor. When the box is full, it is carried to the magazine on a hand-barrow, the contents packed in barrels and piled up. One man is detailed to collect, count, and pack the caps, sweep the floor, and keep it wet, etc. Powder should be removed from the tables and emptied in the box very frequently. No more cartridges than are actually needed to work on, one box for each man, should be allowed in the shop at a time. A space on the table three feet wide is allotted to each man, a partition one foot high being the dividing-line. The box containing cartridges is placed on the table to the left; about 20 packages are opened at a time, the cartridges emptied into one end of the bullet-pan, which should be set directly in front of the workman. Take a cartridge with the thumb and forefinger of the right hand, remove the bullet and drop it in its pan, and empty the powder in the receptacle intended for it. Burnside's metallic, Maynard's metallic, Smith's foil and rubber, Gallagher's paper and wrapped metal, and all other metallic cartridges are broken up by the hand-breaker, unless it be a cartridge otherwise provided for. Brass shells, before being packed, should be taken to an open place on the ground, some distance from the buildings, spread out two or three inches deep in a space about 10 feet square, and sprinkled with a little powder; a match is then applied, and any powder which may chance to be in the shells is thus burned out. Brass shells should never be soaked in water, especially those lined with paper, for they are never afterwards thoroughly dried until melted in the crucible.

The *hand-breaker* is composed of brass and wood, and is 7 inches long. The blade is of brass, $\frac{1}{8}$ inch thick, 1 inch wide, and 4 inches long; oak handle, 1 inch square, edges rounded, and 5 inches long. A slot 2 inches long is sawed into one end of the handle; into this slot 2 inches of the blade is inserted; two holes are bored through for rivets that firmly secure the blade in its place. A hole of the size to suit the ball of the cartridge to be broken up is drilled through the projecting end of the blade about $\frac{1}{2}$ inch from the end. In using this instrument hold it firmly in the left hand over the bullet-pan; insert the bullet-end of the cartridge in the hole and pry upward; the bullet drops out and the powder is disposed of as previously directed.



When breaking up shell-cartridges with a wad between the bullet and powder, the bullet should be removed from two or three hundred before working at the powder. A small brass pick and scraper combined is used, with the edges and point sharpened, with which the wad is removed and the interior of the shell scraped.

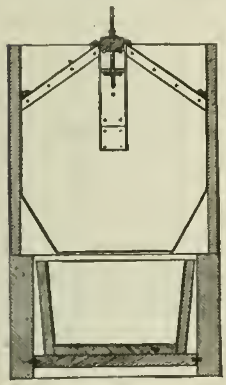
The following-described machine, consisting of a *box*, *drawer-frame*, *drawer*, *magazine*, *firing-bolt*, and *firing-bolt bar*, is used for breaking up metallic cartridges:

The *box*, 2 feet wide, 4 feet long, and 3 feet deep, is lined with ½-inch boiler-iron. The lining should taper inward toward the bottom from both ends and sides, forming an oblong-shaped funnel, the bottom opening being about 1 foot wide by 3 feet long. At each end of the box inside, screwed on about the center, is an upright cleat, oak, 2½ inches wide by 2 inches thick; it extends from the bottom edge of the box to within 1 inch of the top. A rabbet 1 inch deep and 1½ inch long is cut out of the front of the cleat at the top; the shoulder thus formed serves as a rest for the magazine, and the top of the cleat answers the same purpose for the firing-bolt bar. The cleats are covered with the same kind of iron as the box is lined with. The iron should be cut in strips and screwed on. The front is covered first, the covering extending from the bottom of the rabbet to the lower end of the cleat. Cover the sides the same way, except that the strips extend to the top edge of the box; this will form a receptacle at the top end of the cleat, and serve as a slide for the plate. The small plate is then riveted to the large one, the rivet-holes coming between the large ones. The holes for the cartridges are then drilled through the small plate, and should be a little larger in diameter than the cartridge, but not so large as to destroy the shoulder or bearing for the flange of the shell.

The *firing-bolt bar* is made of wood, white oak, 2½ inches wide, 2 inches thick, and about 2 inches longer than the magazine. Holes for the bolts should be bored so that they will come directly opposite the holes in the magazine. Care must be taken to have this correct. Iron washers are screwed on the under and upper sides of the bar over each hole, to prevent their wearing by the action of the bolts. (No. 2 washers for bolts are just the size.)

Firing-bolts are made of ½-inch round bar-steel. They are 7 inches long; about 6 inches are turned off in the lathe to fit the holes in the bar; the other inch forms a head, which is the firing-end of the bolt. About 2 inches from the other end a hole is drilled through to receive a pin. The bolts are then put through the holes in the bar and pinned. This gives them a play of 4 inches. The firing-end of the bolt-head end should be hard, and the striking end soft.

The *frame* upon which the box rests is made of 2-inch pine, and is 1 foot high (the box is designed to set inside this). Two sides and one end are closed. Cleats are nailed inside, about 1 inch from the top



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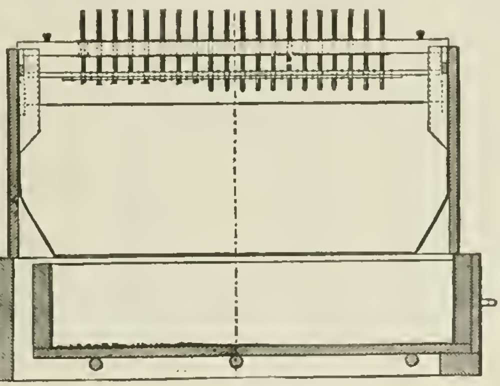

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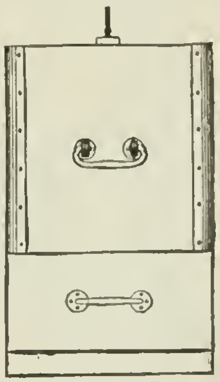


End View.

magazine and bolt-bar that will prevent them from shifting out of place. The cover of the box is made of the same kind of iron as the lining, and in two parts, forming front and back covers; they rest on cleats screwed on the ends of the box inside, and extend from the top edge of the perpendicular cleat to the front and back of the box, the lower end being about 10 inches below the top edge of the box; the covers thus rest on an angle of about 45°. The top edges of the cover should fit snugly against the sides of the firing-bolt bar, but not so as to prevent its being taken out and replaced freely. The back cover may be made fast, as it is not necessary to remove it; the front one, however, has to be removed at every discharge of the magazine, and for this reason has to be a little loose. Oak strips 1 × 2 inches are screwed on the tops of the covers at the lower and upper edges to prevent the iron from warping; the upper one on the front cover also serves for a handle.

The *magazine* is made of iron, has two plates riveted together, the large or upper plate to be ½ inch thick, 2½ inches wide, and long enough to fit in the box lengthwise, its end resting on the rabbet cut in the cleat, the small or lower plate to be ¼ inch thick and 1½ inch wide. Twenty holes, ¾ inch in diameter, are drilled through the large plate on a center line from end to end. They should be one inch apart and commence about 6 inches from the ends of the edge. Upon these the box rests. The other end of the frame is left open for the drawer.

The *drawer* should be made of $\frac{3}{16}$-inch boiler-iron and water-tight, and so constructed that when it is in its place under the box the top edges, both ends, and sides will extend as far as possible inside the lower edges of the lining of the box, thus preventing the bullets and pieces of copper from dropping behind the drawer.

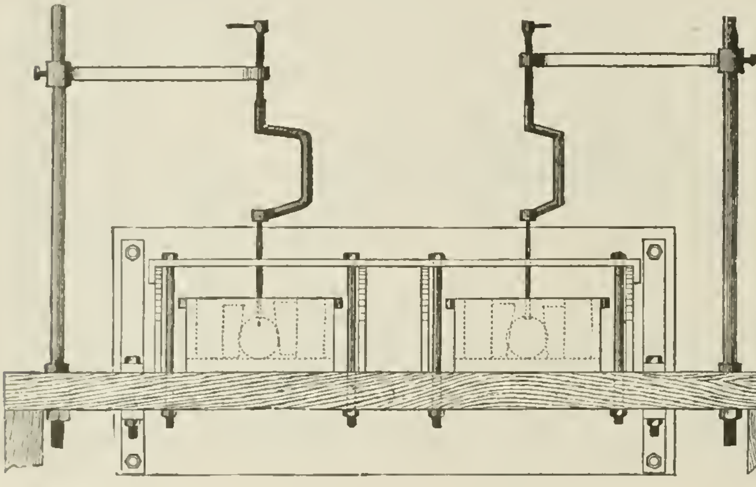
Three men are required to operate the machine: one to load, one to fire, and one to eject the fired shells from the magazine. An open box 5 feet long (an ordinary musket-box answers the purpose) is set at the end of the machine, to the right, across the opening, and about 9 inches from each end. Toward the center a flat strip of ¼-inch bar-iron is attached, the ends projecting about 10 inches over each side of the box. These are to rest the magazine on when being charged, and when the shells are being ejected. They should be far enough apart to catch the magazine about 2 inches from the ends, so as not to interfere with the holes. Three or four magazines are required; also two small hammers, punch, etc.

Everything is now ready to commence operations. The loader (operator No. 1) seats himself at the front of the shell-box, takes a handful of cartridges in his right hand and charges the magazine; passes it to the firing-operator (No. 2), who places it on its rest in the firing-box; takes the firing-bolt bar (which may be placed on the back cover when not in use), sets it on the magazine so that the heads of the bolts drop into the holes; throws down the front cover, that has in the mean time been lifted, takes the hammer from a convenient place and strikes each bolt one smart blow in quick succession. He then lifts the cover and rests it against the front of the box inside, takes out the firing-bolt bar, and lays it on the back cover; takes out the magazine and passes it to operator No. 3, who sits directly opposite the loader. No. 3 then examines it, to ascertain if any of the cartridges have missed fire; if so, he takes them out and places them in a small box for that purpose, turns the magazine, small holes up, punches the remaining shells out into the open box, and then slides it across to No. 1; the other operations in the mean time continuing. The drawer may contain water or not. There is less smoke, however, when water is used, as the ignited powder is sooner extinguished. When about 5000 cartridges have been exploded, the bullets are removed from the drawer and washed, and whatever pieces of copper are among them picked out. Three men can break 10,000 in 8 hours. All primed cartridges, rim and center fire, can be broken up by turns the bag wrong side out and cleans it. The strapped shot are taken to the door of the laboratory, where the shot which still require cleaning are separated from their sabots and immersed in the tub of water; after standing some time they are washed and cleaned; the others remain strapped. The serviceable, reparable, and unserviceable cartridge-bags are separated from each other; the last are immersed in water and used for rags; the pieces of twine are tied up in bundles; the shells are put aside to be unloaded and cleaned in a like manner.

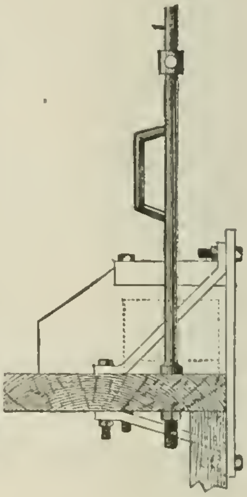
The breaking up of fixed ammunition requires many precautions, and should never be done in the magazine, but as much as possible in the open air. Never have but little powder and a few cartridges in the shop at one time.

Canisters.—Turn up the slit ends of the canisters by means of a small chisel; take off the cover and pull out the balls and sawdust into a box by means of a hook; take out the bottom plate and straighten the cylinder with a mallet on an anvil.

Port-fires—Split the paper; take out the composition, and pulverize it by rolling for two hours. It may be made to burn more or less quickly by adding mealed powder or sulphur.



Rear View.



End View.

the above process. The firing-ends of the bolts should be pointed for the latter. Of course the larger the cartridge the more necessary it would be to have the box larger and stronger.

An improvement is contemplated for the purpose of preventing the pieces of copper from dropping among the bullets. This improvement would necessitate the enlargement of the box, and instead of one drawer three would be required. The box would be partitioned off lengthwise into three compartments, the top edges of the two center partitions to be about 2 inches below the points of the bullets as they hang in the magazine. The pieces of copper always strike the cover and fly towards the front and back of the box, and would consequently drop down the side compartments, the bullets dropping down the center one.

Breaking up Unserviceable Stores.

Fixed Ammunition for Cannon.—1 paulin; 1 box; 2 barrels; 1 knife; 2 brushes; 1 punch; 1 hammer; 1 scraper; tow; a tub half full of water, to clean the balls; stools.

One man holds the cartridge over the box, while another cuts the twine near the knot, takes off the strapped shot, brushes it, and stands it on the paulin on its sabot; the first man pours the good powder into a barrel, the caked powder into another,

Unloading Spherical Case and Shells—Bormann Fuse.

The fixtures consist of tables, protector, water-boxes, drill-presses, drill-braces, drills, etc., as shown in the drawing. The *table* on which the protector is placed is about 3 feet high, and is necessarily heavy, the top being 6 feet long, 2½ feet wide, and 3 or 4 inches thick. The *protector* is composed of iron; the bottom and top plates have bent ends, 4½ feet long and 12 inches wide. Near each end, leaving space enough between them and the bent ends for the admission of the end plates, two 1-inch bolt-holes are drilled; and 18 inches from each of these, towards the center, corresponding-sized holes are drilled, making eight bolt-holes in each plate. These holes are extended through the table. The bottom plate is laid on the table, bent ends up, and its front edge flush with the front edge of the table; the end plates (18 inches long, 12 inches high) are set edgewise on the bottom plate against the bent ends; the top plate is laid on, bent ends downward. The bolts are passed through from beneath the table, thread-end upward, the nuts are adjusted and screwed down to keep the plates together, and the middle or partition-plates are fixed in position. Two partition-plates are necessary in consequence of the front plate having a hole in the center, a partition being placed each side of the hole. Three compartments are thus formed in the protector, but the middle one being useless is filled in with a block of wood. A hole 1¼ inch in diameter is drilled through the top plate over the center of each of the working compartments for the entrance of the drills. The lower edge of the front plate rests on wooden supports; the upper edge projects about 1 inch above the surface of the top plate; it is held in position by four braces, one lower and one upper, at each end. The outer ends of the braces are bolted to the corners of the plate, and the inner ends are clamped together by means of a screw-bolt and nut; the bolt passing through the table and bolt-braces. The *water-boxes* are made strong, about 7 inches deep. They are 16 inches long and 10 inches wide, outside measurement. The ends are 4 or 5 inches thick. Having the box in the same position in its compartment every time it is replaced is essential; and for this purpose strips are made fast to the bottom plate to serve as guides for the box to slide between. The *drill-presses* are fixed to the table at each end of the protector and have sliding arms. The thread-end of the perpendicular bar passes through the table, and by means of a nut is firmly fastened. The sliding arms have set-screws, one to make it fast to the perpendicular bar, and one at the other end to press on the drill-brace. The press is so attached to the table that the points of the set-screws are in a direct line above the drill-holes in the top plate. The *drill-braces* are iron; one end having a socket for the drill, and the other end is countersunk for the point of the set-screw. The *drills* are steel and are about 10 inches long; the small ones are ¼ inch wide at the drill-end and pointed; the large ones are 1¼ inch wide and ⅛ inch thick at the drill-end. The blade has a round blunt point projecting from its center, and is straight each side of the point, with slightly beveled opposite edges. A smaller table is used in the operation of removing the iron plugs, the water-box for this purpose being screwed fast to the surface of the table; a small iron wrench with two teeth to fit the holes in the plug is used. A bench-vise should be attached to this table. A small hand-punch, monkey-wrench, heavy riveting-hammer, and a small ½-inch cold-chisel are necessary tools. A tub or iron pot to hold water, in which to place the shells after having the plugs removed, is used. When *case-shot* are being unloaded, a heavy hand-hammer is needed to strike the shell on the outside so as to crack the casing inside.

All *spherical projectiles* can be unloaded by the above plain; and if the following directions are carefully followed explosions cannot possibly occur:

First. Fix the shell firmly by means of a wooden wedge in the water-box. Be sure that the quantity of water in the box is sufficient to cover the fuse; then slide the box in its compartment in the protector so that the location of the fuse is in a direct line beneath the drill-hole.

Second. Place the point of the small drill on the center of the fuse, and set the other end into the socket of the brace, lower the brace on the drill to avoid displacing the point; bore the hole through the fuse and iron plug, if a Bormann fuse; remove the drill and work the water into the powder with a brass wire; set the large drill in the same manner as the small one, and remove enough of the fuse to uncover the entire surface of the iron plug; remove the shell from the box and put in the water-tub.

Third. The shell is taken from the tub by another operator, who secures it in the fixed water-box, and with the cold-chisel cuts through one side of the fuse; he then strikes one end of the ring at the cut and drives it in toward the center of the iron plug; this will detach it from the thread of the shell. With the toothed wrench extract the iron plug. The shell is replaced in the tub from whence it is subsequently taken and the powder removed.

Three men can unload from 100 to 115 shells, Bormann fuse, in 8 hours; and four men can unload the same number of case in the same time. See *Ammunition.*

BREAST-HEIGHT.—The *interior slope* in fortification, sometimes called the *breast-height*, is the part against which the assailed naturally lean in the act of firing. It has usually a slope of three perpendicular to one base. This is a result of experience, being the most convenient one for a soldier leaning forward to fire over the parapet. See *Field-fortification.*

BREAST-LINE.—The rope connecting the pontons of a military bridge in a straight direction.

BREASTPLATE.—In ancient armor, a plate of iron, steel, or other metal, so fastened as to protect the chest or front of the wearer. The back-plate, in like manner, was worn to protect him from attack from behind. In modern European armies, almost the only representative of the breastplate is the front half of the *cuirass*, worn by the *cuirassiers* in certain foreign States, and by the Household Cavalry (Life-guards and Horse-guards) in England.

BREASTWORK.—In fortification, a hastily constructed earthwork; not so high as to need a *banquette* for the defenders to stand upon, but sufficient to afford shelter when they are standing on the level of the ground and firing over the crest. The dry ditch or trench from which the earth has been taken to form the breastwork affords an additional defense. A breastwork is midway between a *parapet* and an *epaulement* in size and importance.

BREECH.—The mass of solid metal behind the bottom of the bore of a gun extending to the rear of the base-ring. The *base* of the *breech* is a frustum of a cone or spherical segment in rear of the breech. The excess of metal at the breech is to enable the gun to withstand the shock occasioned by the explosion of the gunpowder. Small-arms have also an increase of metal at the breech. See *Cannon.*

BREECH-BLOCK.—A movable piece at the breech of a breech-loading gun, which is withdrawn for the insertion of a cartridge and closed before firing, to receive the impact of the recoil. This is the great problem of the breech-loading gun. There are at least one hundred species of breech-blocks, classified according to the mode of moving the block relatively to the barrel, or the barrel to the block. See *Springfield Rifle.*

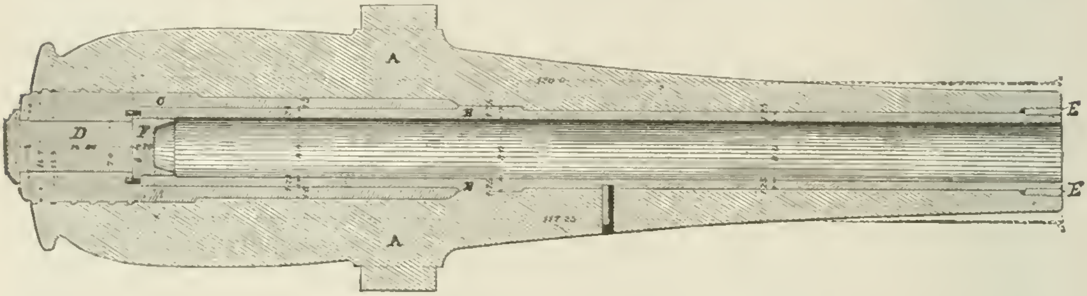
BREECH-CASING.—A component part of most machine-guns. It is usually a hollow cylinder, extending from the front end of the lock-cylinder to the rear portion of the frame. Flanges on its sides rest on and are screwed to the frame; near the rear end is a partition called the *diaphragm-plate*, which divides the cylinder into two parts and separates the lock-cylinder and revolving-gear. In the forward division are placed the cams for forcing forward and drawing back the locks. See *Gatling Gun.*

BREECHING.—1. The breeching of a gun or carronade is a strong rope by which the recoil of the gun is checked at such a point that the muzzle is brought wholly within the port-hole, where the seamen can sponge and reload it. 2. Harness adapted to the wheel-horses of gun-carriages, *near* and *off*, for the purpose of facilitating the stopping of a gun in motion. Breechings, near and off, are strengthened with a lay of leather.

BREECH-INSERTION.—The difficulties of securing perfect weldings in coiled wrought-iron tubes have led in some instances, in the history of the employment of linings constructed in the manner and on the present plan of muzzle-insertion, to the development of grave accidents in service, tubes being blown out and the muzzles torn off, all from defective welds. The most satisfactory and secure remedy for this imperfection undoubtedly lies in the provision of a shoulder on the tube (in front of the charge), the gun being recessed for its reception. An otherwise strong and durable construction, embodying this feature, must accordingly have an important advantage over the present plan of muzzle-insertion, in which no adequate provision can be made to prevent the destructive effects of a tube being blown out. This accident is likely to occur if all the welds are not sound—a perfection which it is impossible, from the nature of the construction of coiled wrought-iron tubes, to uniformly and certainly attain. The uniform success of our present guns is in a measure due to excellence of work and care in manufacture; but it is evident that a decided improvement attains, if we can have perfect immunity from the defect alluded to above, while securing a perfectly reliable construction in other respects. A consideration of the question has led to the construction of a gun on an improved plan of *breech-insertion*, having, it is believed, more durability than the present plan of muzzle insertion, and securing the other advantages above quoted. The imperfections of breech-insertion, in alterations heretofore made, have arisen from the mode of construction employed, to wit, separating the breech-plug from the strengthening tube shrunk on the inner tube or lining; also from the solid construction of the plug. The throwing of the entire longitudinal strain on to a breech-plug by depriving it of all assistance from the longitudinal strength of the enveloping jacket produces a line of longitudinal weakness at the junction of the tube and plug, where the longitudinal and tangential strains, under fire, combine to produce rupture. This fact is well established by experiments in England.

In the construction under consideration, the jacket is shrunk on the tube, and extends continuously with tion of the general features of the construction. It will be seen that the jacket (1.5 inch thick) extends to the front a distance of about 40 inches from the bottom of the bore, thus reinforcing the inner tube (1.25 inch thick) to a greater length than in the case of the B tubes of the present constructions, and consequently fully strengthening it over all the space where the pressures are at all dangerous.

The drawing represents a 10-inch Rodman smoothbore gun, with its lining inserted from the breech. The gun is essentially composed of three parts: (A) the original 10-inch smooth-bore, bored out to receive the lining; (B) a lining tube of coiled wrought-iron (welded), with a jacket (C) of wrought-iron with its hollow base or plug extending to the face of the breech; and the breech-plug (D). The bottom of the tube is closed by a wrought-iron base or cup (F). A shoulder, on the inner tube, prevents the tube from being thrust forward by the effects of repeated firings, or blown out from imperfect coil-welds. A screw collar, E, at the muzzle, gives additional security, resisting any forward thrust of the metal of the tube in front of the shoulders. It will be seen that the play between the cast-iron body and tube and jacket does not exceed .01 inch for a length of 88 inches from the muzzle, nor .004 inch from this point to the commencement of the screw-thread. The greatest diameter of the tube and jacket is 14.7 inches. The diameter of the tube from the muzzle-collar to the first shoulder is 10.5 inches. The maximum thickness of the tube and jacket is therefore 3.35 inches, and the minimum thickness of the tube is



Ten-inch Rodman Smooth-bore Gun, with Lining inserted from the Breech.

a uniform thickness from a point a short distance in front of the trunnions to the breech-cup of the inner tube, and thence, with an increased thickness, clear through the breech to its face. This unbroken continuity, and the yielding, hollow, wrought-iron breech thus formed, give all the strength desirable at the bottom of the bore to resist the combined longitudinal and tangential strains at that point; and the breech portion of the jacket, by its hollow form being permitted to expand in unison with the tube when the latter is distended under the strains of discharge, avoids the danger of rupture liable to result from the rigidity of a solid, unyielding breech. A square-cut plus thread cut on the breech portion of the jacket corresponds with a minus thread cut on the cast-iron, each to form the union of one with the other. The area of cross-section of the wrought-iron is such as to have its strength proportional to the strength of the thread on the cast-iron, reference being had to the relative strength of the two metals. The breech portion of the jacket, it will be observed, is so constructed as to overlap the bottom of the tube and the exterior portion of its cup. The longitudinal thrust consequently is, at this point, principally borne by the wrought-iron jacket, and not by the secondary breech-plug, simply used to close the hollow part of the former. By these arrangements, the greatest resistance is secured to longitudinal strains. A breech-plug of cast-iron completes the construction of the breech. The inner tube, *shouldered* and closed at the bottom in the usual manner, completes the mention 1.25 inches. The rifling of the gun consists of 15 lands and grooves, each of equal width.

Width of lands and grooves.....	.8377	inch
Depth of grooves...............	.075	"

Twist uniform, one turn in 40 feet. The rifling stops at a point 10 inches from the bottom of the bore, and the diameter of the unrifled portion of the bore is equal to that of the rifled portion across lands. The old vent is closed (the copper bushing having been removed) by a wrought-iron screw-plug, and 2.75 inches nearer the muzzle a new one was bored, parallel to the vertical plane through the axis of the bore, and distant therefrom 2.50 inches. The axis of the vent enters the bore at 3.5 inches from the bottom. See *Converted Guns* and *Ordnance*.

BREECH-LOADER.—A fire-arm that receives its load at the breech. Breech-loading small-arms of the new system may be divided into *simple breech-loaders* and *repeaters*. The principal parts peculiar to the former are: 1st. The *movable breech-block*, by which the chamber is opened and closed; 2d. The *breech-frame* upon which the breech-block is mounted and united to the barrel; 3d. The *chamber*, with its counterbored recess, to receive the rim of the cartridge; 4th. The *firing-pin*, which transmits the blow of the hammer to the priming of the cartridge; 5th. The *extractor*, by which the empty case is removed after firing. In addition to these parts, the repeater has a magazine attatched to it to contain a certain number of cartridges, which are successively brought into the chamber by peculiar mechanism.

The foregoing-named parts may be said to be essential to all breech-loading arms in which the metallic cartridge is used; the different ways in which they are combined mark the different systems now in vogue. These combinations have reference chiefly to the modes of operating and locking the breech-block. The breech-block may be operated in two ways: 1st, by *rotation*, where it swings on a hinge; 2d, by *sliding*, where it moves in grooves. The former mode is generally to be preferred, as the rubbing surfaces are small, and the power is applied at the end of a lever: in the same way that it is easier to close a hinged door than a sliding one. In the rotating breech-block, the position of the hinge has an important influence on the facility of operating the block, inserting the cartridge and withdrawing the empty shell, and the most suitable position is deemed to be in front of the center of the block. In this case the motion of opening and closing the block is natural and easy, the cartridge is pushed into its place by the block, and a very simple retractor serves to withdraw the empty shell after firing. The Allin (Springfield altered), Berdan, Millbank, Lamson, Remington, Laidley, and others belong to this class. In the last two named the hinge is below, in the others it is above, the axis of the block. In the Snider (Enfield altered), Warner, Maynard, and others the hinge is on the side of the block; while in the Peabody, Roberts, and others it is in rear. In the Prussian Needle, the French Chassepot, Root, Meigs, Sharp, and other guns the breech-block is made to slide. There is another system, however, in which the breech is opened by moving the barrel. This system is better adapted to sporting than to military guns.

The following are among the more important conditions to be fulfilled in constructing a breech-loading gun of the new system, viz.: 1st. The strength and union of the parts should be such as not only to resist repeated discharges, but the bursting of a cartridge-case, which sometimes occurs from defective material or workmanship. 2d. The locking of the breech-block should not only be secure, but all the parts by which it is effected should work freely—without sticking. 3d. The parts should be so arranged that the hammer cannot strike the firing-pin until the breech-block is properly locked. 4th. The piece should not be carried loaded with the hammer resting on the firing-pin. 5th. Avoid, if possible, the necessity of bringing the hammer to the full cock in order to unlock the breech-block. 6th. The working parts should, as far as possible, be covered from dust and water. 7th. The extractor should be so arranged as to require no cuts or openings in that part of the chamber which surrounds the body of the cartridge-case.

In relation to muskets and fowling-pieces, Mr. Greener, of Birmingham, who has written much on the subject, disputes the usefulness of breech-loading; he denies that it is more safe, more accurate, or more forcible than muzzle-loading; while certain advantages which it may possess are, he thinks, counterbalanced by the greater cost of the weapon. The relative merits of breech- and muzzle-loading

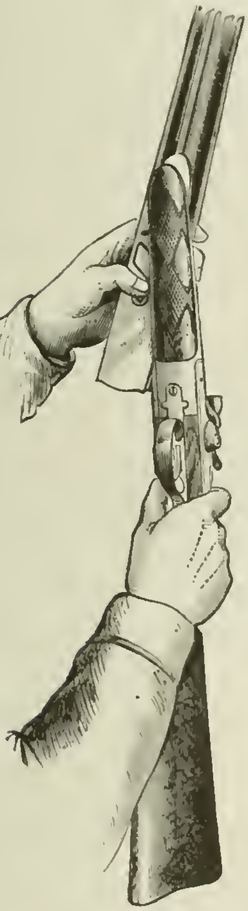


Fig. 1.

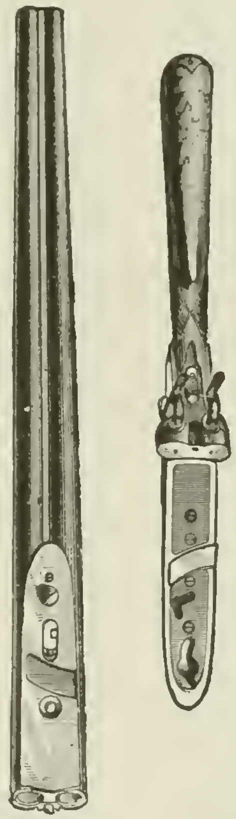


Fig. 2.

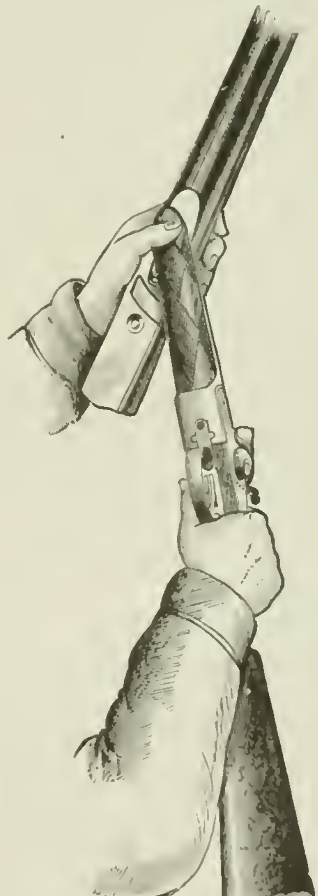


Fig. 3.

fowling-pieces were tested in 1859–60 by various trials, under the management of the editor of *The Field*, and resulted in favor of the breech-loaders. The demand for the latter has, in consequence, enormously increased. The drawing illustrates the Fox breech-loading gun, one of the most satisfactory arms yet invented. Fig. 1 shows the position when about to detach the barrels; Fig. 3, when about to attach the barrels; and Fig. 2 shows the stock and barrel apart. The various breech-actions and distinguishing features are noticed in various parts of the Encyclopedia, in connection with certain kinds of ordnance and small-arms expressly constructed on the breech-loading principle.

The introduction of breech-loaders in the United States dates properly from 1865, from which date muzzle-loading arms were no longer manufactured at the Springfield Armory. A short time before the late Rebellion, the Government tested a number of breech-loading guns, such as the Burnside, Cosmopolitan, Gallagher, Joslyn, Merrill, Maynard, Smith, Lindner, and Sharp. None of these are now used except the Sharp gun, which has been adapted to the metallic cartridge. During the war the Spencer rifle was much used by the U. S. cavalry; it has a magazine in the butt of the stock, holding 7 cartridges that are admitted one at a time by the movement of the trigger-guard used as a lever. The shell of an exploded cartridge is expelled by the same movement. It may be used also as a single breech-loader, but the magazine must first be shut off. The Henry gun (not to be mistaken for the Martini-Henry) has the magazine under the barrel. By movements of the lever 17 metallic cases or cartridges can be brought into the chamber in succession. This gun, like the Spencer, can be used as a single breech-loader by shutting off the magazine. It has been changed, however, by O. F. Winchester, and is now termed the Winchester gun. Among other magazine-guns may be mentioned the Ball, Fogarty, and Gardner guns. The well-known Remington gun is a single breech-loader, and has an iron receiver that is screwed to the breech of the barrel, in which the breech-block and lock are to be found. It uses metallic-cased cartridges, and has been adopted by the Governments of Egypt, Spain, and several other countries.

In 1866 the Secretary of War called a Board of Officers, General Hancock acting as President, to report the form and caliber which should be adopted for breech-loading muskets and carbines, and the method of converting muskets from muzzle-loading to breech-loading arms. After an examination of 22 different breech-loading muskets and 17 different breech-loading carbines, the Board reported the best caliber for muskets to be .45 of an inch, the best charge of powder from 65 to 70 grains, and the best weight of ball from 480 to 500 grains. In 1869, a Board of Officers, presided over by General Schofield, was called to meet at St. Louis to select the six best patterns of muskets for infantry and carbines for cavalry. After examining a great number of different breech-loaders, they reported that the only guns suitable for military service were those of the Remington, Springfield, and Sharp systems. These guns were tried accordingly until 1872, when, in compliance with an Act of Congress, a Board of Officers, General A. H. Terry as President, was appointed to meet in New York and Springfield, "to recommend a breech-loading system for muskets and carbines to be adopted for the military service, which system, when so adopted, shall be the only one to be used by the Ordnance Department in the manufacture of muskets and carbines for the military service." After testing over 100 breech-loading guns, the Board recommended (May, 1873) that the Springfield breech-loading system be adopted for military service, and this report being approved, that system is now used by the Government for the U. S. army and militia. This breech-loader has a receiver screwed to the breech of the barrel. The shell of the exploded cartridge is ejected by a combined cam and spring through a motion of the hinge in the opening of the breech-block. The firing-pin goes through the breech-block in an inclined direction from the nose of the hammer at the side to the center of the rear of the chamber, where it strikes the head of the cartridge, exploding the fulminate when its rear end is struck by the hammer. See *Springfield Rifle*.

BREECH-LOADING CANNON.—Intimately connected with the subject of the different systems of rifling is that of the advantages and disadvantages of breech-loading for cannon. There are strong arguments both for and against the use of the breech-loaders—some nations using them altogether, and others not at all. A principal advantage claimed for the breech-loading guns is rapidity of fire, but the result does not seem to have been attained in the large guns. The gun can be loaded when run out, without exposing the men, and worked in a smaller space by limiting the recoil. Any ignited substance left in the bore can be seen and removed; and there is no danger of the projectile not being home. The breech-loading gun may be made longer, occasionally, which is a great advantage where there is difficulty in burning the powder; moreover, a large powder-chamber may be employed for the better burning of the charge. The advantages of the compressive system of rifling may be claimed in favor of breech-loading.

The breech-loading cannon is heavier and more expensive than one loading at the muzzle. There are more parts to be damaged. In heavy guns, far from there being any increased facility in loading, considerable force has to be used and applied in a very careful way to the breech-closing apparatus, or the gun may be rendered temporarily unserviceable. Escape of gas, fouling or corrosion of the closing surfaces, and injury to the delicate Broadwell ring or gas-check, are among the contingencies that may arise in service. Much additional labor and outlay are required to construct and fit up interchangeable hollow screws or sliding stoppers; to fit and renew gas-checks; to apply opening and closing apparatus, which cannot be very simple, but which must be very strong and durable; to fabricate, keep clean, and maintain all these parts on such a plan that two or three men can manipulate them with ease and certainty, and without unusual risk of disaster from excitement or carelessness; and of such size and strength that the heaviest projectiles can be fired, with large charges of powder.

The adoption of a system of working and loading guns by hydraulic power must have an important bearing upon the question of the comparative merits of breech- and muzzle-loaders. One of the chief advantages claimed for breech-loaders is that any length of bore can be adopted without increasing the difficulty of loading, and that therefore a higher duty can be obtained from the powder. It has also been urged that a gun of larger size can be worked in a given turret as a breech-loader. Successful mechanical methods for loading at the muzzle would seem to negative these advantages. The suppression of windage and the power of placing the vent in the breech-block are important advantages claimed for breech-loaders. The vent is a serious trouble in very heavy guns, from its rapid erosion by the gases of discharge. But it is claimed that the windage can be effectually suppressed in many muzzle-loading systems of rifling and projectiles, and an arrangement has been devised for stopping altogether the passage of gas through the vent, thus removing the difficulty of its erosion. See *Ordnance*.

BREECH MECHANISM.—The mechanism used for opening and closing the breech of a fire-arm and securing it against the escape of the gas. In small-arms this is readily accomplished. The use of the metallic cartridge-case renders any special gas-check unnecessary, as the case itself by being expanded against the walls of the chamber serves the purpose. The various mechanisms used in small-arms have been classified as follows: 1st. Fixed chamber; 2d. Movable chamber. The second class is now obsolete. The fixed-chamber class is subdivided into—1st. Barrel moves; 2d. Breech-block moves. The first class comprises many of the shotguns in use; the second, the best known of military arms. Under this latter class are the following subdivisions: 1st. Sliding block; 2d. Sliding and rotating; 3d. Rotating about an axis. We find excellent guns under each of these classes, which are further subdivided as to the direction of the motions. The Sharp may be taken as typical of the first of these classes, the Hotchkiss magazine-gun of the second, and the Springfield of the third. A similar classification may be made for breech-loading devices in heavy ordnance, but the problem here is not so simple. The pressure is much greater, the masses of metal much larger, and the cartridge must be used without a case to check the gas. Breech-loaders were impossible until the problem of checking the gas had been solved. The inventor of the first successful gas-check was an American, L. W. Broadwell, now residing abroad. The term "Broadwell ring" has been applied to all similar devices. This is a steel ring which fits in a recess reamed out in the rear of the chamber and abutting upon the breech-block. The inside of the ring is so shaped as to be pressed by the gas outward and backward, thus closing both the space outside the ring and between it and the block. Broadwell is also the inventor of a breech mechanism which, with a few modifications, is that used by Krupp for all of his guns. The breech-block slides horizontally through a rectangular slot in rear of the chamber. In the Armstrong breech-loader, the block called the vent-piece is taken out and put in through a rectangular orifice on the top of the gun. It is locked in place by a hollow breech-screw. The French use a breech-screw with the threads cut away in longitudinal rows. The female screw being similarly arranged, a very small rotation enables it to be entirely withdrawn. Among American devices are Thompson's, a breech-block which rolls to the side and opens or closes the bore: Sutcliffe's, a cylindrical block, with its axis parallel to the one hanging on a pin projecting from the front periphery of the hollow screw,—the block is raised and locked by turning the screw, and falls into a recess below when the screw is half turned back: Mann's, in which the gun rotates upward about the trunnions something like a shotgun: and many others.

BREECH-PIECE.—A solid forging of wrought-iron. It is bored, turned, and shrunk on to one end of the barrel. The breech-piece of the larger natures is welded to the coil in front of it.

BREECH-PIN.—A plug screwed into the rear end of a barrel, forming the bottom of the charge-chamber. It is frequently called a *breech-plug* or *breech-screw*. See *Blank*.

BREECH-SCREW.—A screw composed of a body, tenon, and tang, employed to close the bottom of the bore. The screw usually fits into the thread cut in the breech-piece, and is worked forward or backward by the lever and tappet so as to press home or release the vent-piece. It is bored hollow to allow of the charge being passed through in loading the gun; the diameter of the hollow is rather larger than that of the powder-chamber. It is made of steel for 20-pdrs. and lower natures of gun, of wrought-iron or steel for 40-pdrs., and of wrought-iron faced with steel for the 7-inch guns. See *Breech-pin*.

BREECH-SIGHT.—With the exception of mortars, all modern pieces are furnished with two sights, a front one and a rear one. These are situated either on the *line of metal*, or slightly to the right of it in a plane parallel to the plane of fire. The front sight is securely attached to the piece by means of a screw, and for the heavier class of guns is over the axis of the trunnions. The rear sight is on the breech, fitting into a socket attached to the piece with screws, and when the gun is to be discharged is removed from the socket. For the 10- and 15-inch guns the breech-sight is without graduation, and serves merely to give direction to the piece, the elevation being given by means of the *elevating-arc*, or, when practicable, with the quadrant applied in the muzzle.

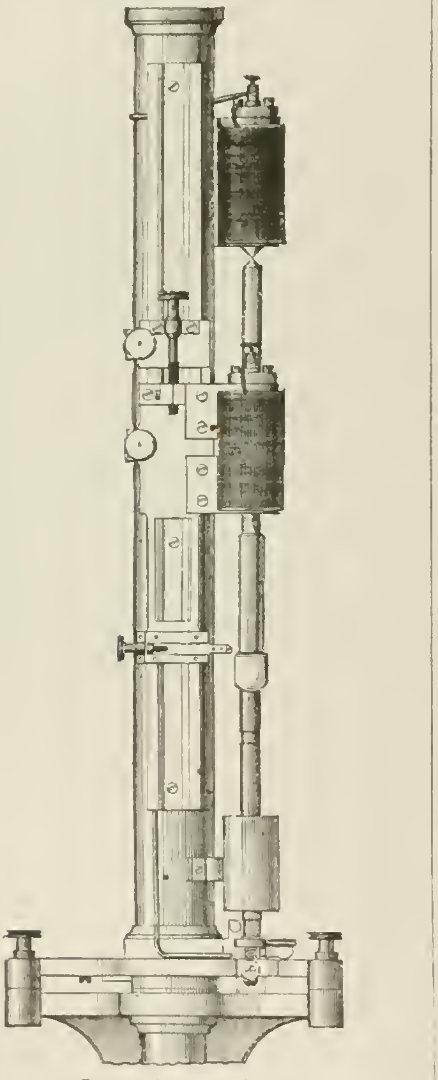
For siege and Parrott guns the breech-sights are graduated to correspond to degrees and parts of degrees of elevation of the axis of the bore, and have a slide to move up or down. This slide has a screw-thread cut on one end of it, upon which works a nut with four short arms; through each of these arms is a small hole for sighting. The screw upon the slide is for the purpose of giving lateral motion, when allowing for drift. Each kind of gun has its particular breech-sight, but, as there are in service many of old or experimental pattern, they should be verified for the particular pieces upon which they are to be used. This is done by directing the piece at some well-defined point at a distance of 1000 yards or more, and on the same horizontal plane with the axis of the trunnions. A straight-edge and spirit-level applied to the face of a trunnion suffice for this operation. Place the slide of the breech-sight at any degree of the graduation, and, sighting through it at the object, give the piece the corresponding elevation. Insert the gunner's quadrant into the bore, and ascertain from it the inclination of the axis of the piece. If the reading on the breech-sight corresponds to that of the quadrant, the former is correct. The line of sight passing through the zero of the breech-sight is parallel to the line of fire.

For 10- and 15-inch guns an *elevating-arc* is used. This consists of a strip of brass attached to the base of the breech parallel to the ratchets. It is graduated into degrees and parts of degrees, and a pointer, attached to the ratchet-post, indicates the elevation or depression of the piece. When the pointer is at zero, the axis of the piece is horizontal. Besides the graduation on the arc, the ranges in yards for the ordinary charges for shot and shell are given. In batteries for garrison and sea-coast defense, where the platforms are fixed, the line of metal may be considered as permanent; but with siege-guns, mounted on traveling-carriages, the wheels are liable to vary in position from unevenness of ground or unequal settling in newly-constructed platforms. This line is constantly changing, and approximates the higher wheel in proportion to the difference of level between the wheels; hence, to secure accuracy of fire, allowance must be made by observing where the shots strike and correcting the aim accordingly. Deviation from this cause is always towards the side of the lower wheel.

BREECH-WRENCH.—A wrench employed in turning out the breech-pin of a fire-arm.

BREGER CHRONOGRAPH.—This apparatus, or a modification of the Le Boulengé chronograph, is intended to measure the interval of time, T, which elapses between the successive ruptures of two electric currents. It is principally employed to determine the velocity of projectiles, in which case two vertical frames are placed in front of the gun, on each of which is stretched the conducting wire of one of the two currents. In traversing the frames the projectile cuts the circuits and causes the chronograph to act. The distance, D, between the frames being known, the mean velocity of the projectile during the time, T, is $V = \frac{D}{T}$. When T is compressed between 0^s.05 and 0^s.15 the conditions are favorable, although the apparatus may be used to measure a shorter time.

The chronograph consists of a vertical column, to which are affixed two electro-magnets; one magnet is actuated by the current of the first frame and supports an armature called the chronometer; the other is actuated by the current of the second frame and supports an armature called the registrar. The chronometer is a long cylindrical brass tube terminating at its upper extremity in a piece of soft iron and bearing at its lower extremity a steel bob. It is surrounded by a zinc or copper cylinder called the recorder. The registrar is of the same weight as the chronometer, and is a tube with soft iron and bob. The cores of the electro-magnets and the soft iron of the armatures terminate in cones slightly rounded at their vertices in order that the armatures when suspended can take a vertical position. When the registrar is set free it strikes a horizontal plate, which turns upon its axis and releases a spring furnished with a square knife, which strikes the recorder and



Breger Chronograph.

leaves an indentation upon it. If the two currents be ruptured simultaneously the indentation is found upon the recorder at a height, h, indicating that since the chronometer commenced to fall the time t has elapsed. $t = \sqrt{\frac{2h}{g}}$. It is evident that t is the time required for the apparatus to operate; it is a systematic retardation inherent in the instrument. A special organ, called the disjunctor, permits the simultaneous rupture of the circuits to be produced, so that the time, t, is always known. A very simple device is resorted to in order to render it constant. If the current of the registrar is not ruptured until after that of the chronometer, and if an interval, T, has elapsed between these ruptures, the time during which the chronometer will fall before receiving the indentation of the knife will simply be augmented by T; and calling H the height of the indentation, we will have

$$t + T = \sqrt{\frac{2H}{g}}.$$

Thus the determination of any interval, T, always comprises two operations: the measurement of the time, t, required for the instrument to operate, and that of the time, $t + T$. The difference of these two measurements gives the time sought. This indirect method of ascertaining the result is the characteristic of the instrument and explains its accuracy. When the rupture of the currents is produced by the projectile, the portion D of the trajectory between the targets is regarded as rectilinear, and the mean velocity, V, is

$$V = \frac{D}{\sqrt{\frac{2(H-h)}{g}}}.$$

A table may be calculated giving the values of V for different values of D and H. If D, h, and H have been accurately measured and the disjunctor has ruptured the currents at precisely the same instant, the velocity, V, will be subject to no error, provided, however, that the time required for the operation of the instrument has remained the same at the time of disjunction and of experiment. The time necessary for the operation of the instrument is composed, first, of that which elapses from the instant the registrar commenced to fall until the blow of the knife is given to the recorder of the chronometer, and this first part will necessarily be the same in two successive operations if the element of the recorder which receives the mark falls in the same vertical line. From the instant that the current is ruptured until the armature is free to fall, a time, θ, elapses which is called the *retardation of demagnetization;* therefore the time, t, includes also the algebraic difference $\theta' - \theta$ of the retardation of demagnetization of the registrar and chronometer; but as both electro-magnets are similarly constructed, as the weights of their armatures and the currents that actuate them are equal, as, in a word, they are in the same magnetic state, the times θ and θ' are sensibly equal. In fact, these times do vary with the mode of rupture, and consequently when a projectile is substituted for the disjunctor, but by the same quantity, as everything remains the same in the two electro-magnetic systems. It will be remarked that it is not necessary that the times θ and θ' should be exactly the same, but only that their difference should remain constant in the successive operations in which the instrument is used. The suspension of the armature is effected in the same manner as with the original instrument. In the instrument supplied to the United States by Mr. Hotchkiss and constructed by Mr. Froment, several details have been improved. 1st. The magnets have been provided with a movable core, worked by a set-screw and counter-screw. This allows a more perfect regulation of the currents than when the rheostat only is used. 2d. The instrument is provided with a spherical spirit-level, which allows to place it vertically without difficulty. 3d. The knife, trigger, and indexes are all provided with set-screws, enabling them to be perfectly and easily adjusted. One of the most important points being the constancy of the currents, Mr. Froment has studied a special modification of the Callot battery for the use of the chronograph. Each battery is actuated by a battery of forty elements, coupled in four series of ten. This battery will work for several months without any perceptible variation. See *Le Boulengé Chronograph.*

BREITHAUPT FUSE.—This fuse, sometimes called the Field-artillery fuse, resembles the Bormann in its general appearance, and is made of a mixture of tin and lead. The body of it is formed like that of the Bormann; but the outside has no screw, and it is placed in the eye of the shell by means of a projection from the bottom, which is threaded, and which screws into a corresponding aperture at the bottom of the eye. The composition is laid in exactly the same kind of a channel, which communicates with the magazine in a somewhat different way from the Bormann fuse. At the top two mortises are placed, in which the prongs of the screw-driver fit when screwing or unscrewing the fuse from the shell. In the center is a socket with the thread of a screw to receive the end of the *pressure-screw*, which is made of iron. The stopper and regulating disk is cast of the same kind of metal as the fuse, and has through its center a cylindrical hole for the passage of the pressure-screw. A small priming-chamber, in the form of a hopper, is placed at the side, one of the lateral projections of which, marked with a red line, serves as an index to regulate it. A small projection on its surface gives a hold to the finger to turn the disk on its axis, in order to bring the index opposite the required point on the scale of the fuse. A piece of pliable leather or skin is pasted on the under surface of this disk, in order to insure contact throughout and preserve the composition from moisture. The composition is pressed into its place by machinery. It is meal-powder for Shrapnel fuses, but ordinary fuse-composition for the fuses of other shells. In the first case the fuse burns 7 seconds; in the second, 14 seconds. The regulating scale is a rondelle of white paper pasted on the outside upper edge of the fuse. It is made like a dial, with strokes, half-strokes, and quarter-strokes, radiating from the center, corresponding to intervals in the combustion equal to 1 second, ½ second, ¼ second, and ⅛ second. The rondelles are cut with a stamp-iron or punch. Care must be taken in pasting the scale on to make the zero of it coincide with the edge of the solid part where the magazine-vent debouches into the composition-channel. The priming consists of a small strand of quick-match, bent double, with the bend fixed in the priming-chamber by means of a paste of meal-powder. The ends are free, so that when the priming is uncapped the ends project outside the little hopper-shaped chamber. The priming-cap is a small circular-sided trapezoid of gold-beater's skin, which is pasted over the priming-chamber by its four edges to protect the priming as well as the fuse-composition from dampness. A rondelle of soft leather is cut out and fitted on the bottom of the fuse around the bottom stem, as a packing to the joint between the shell and fuse. The magazine and vent leading to the fuse-composition are filled with fine powder, and the bottom closed with a thin sheet of lead, kept in its place by four notches; a coat of varnish being given to the outside to keep out moisture.

It is an improvement to engrave the scale upon the metal itself instead of placing it on a strip of paper, which in service is liable to be worn or torn off, or the graduation made illegible. This fuse was invented after the Bormann and Baden fuses had been extensively adopted by different nations, and the great objection to its adoption was the extensive changes required in the *eyes* of the shells already manufactured. This difficulty was obviated, however, by transforming the Baden into the Breithaupt fuse by means of some slight changes which did not affect the form or exterior dimensions, nor its scale or composition-channel. See *Fuse*.

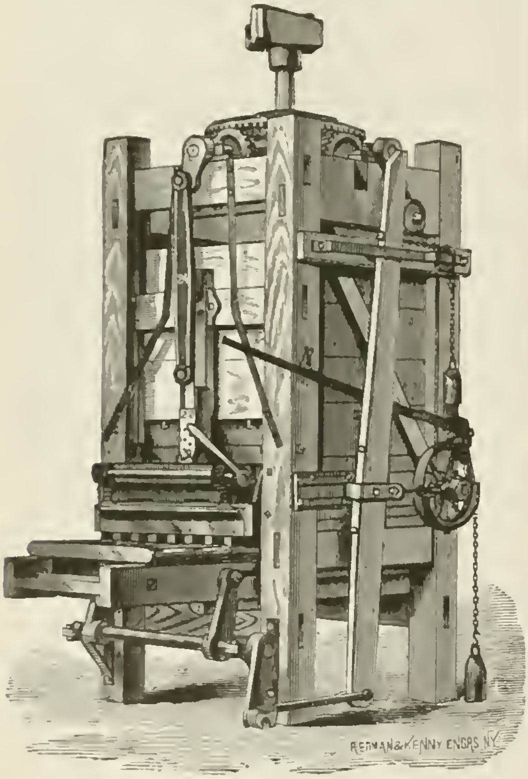
BREVET.—In the British army, a promotion of officers, now strictly limited in its application, but before 1854 a recognized though occasional mode of conferring a large measure of general promotion throughout the army. It took place under various circumstances. If no special cause interfered, a general promotion by brevet used in former times to be made once in about six years; but in more recent years it was limited to very special occasions, as a coronation, the birth of an heir to the throne, the termination of some great war, etc., and was limited to officers who had some particular claim to promotion. The officers so promoted obtained an increase of rank, and in some cases pay, even if they had never served in the field. A brevet was determined on by the Cabinet, and carried out by the Commander-in-Chief. The officers expected it, as one of the implied conditions on entering the service, and it had formed part of the British military system ever since the time of James II.; but it was unsatisfactory, because the flow of promotion caused by it was arbitrary, uncertain, and much liable to abuse. There were brevets, arising out of the various circumstances above indicated, in 1837, 1838, 1841, 1846, 1851, and 1854. On these occasions, Lieutenant-generals, Major-generals, Colonels, Lieutenant-colonels, Majors, and Captains received a promotion of one grade in rank. On one of these occasions, 200 Colonels were at once made Major-generals. The higher the rank the higher the pay, as a general rule; and therefore the cost to the nation is always increased for a time after each brevet. Thus the brevet of 1837 occasioned an annual increase of £11,000; that of 1838, £7000; of 1841, £15,000; of 1846, £21,000, etc.; but it must not be forgotten that death and sales had in the intervals cleared off perhaps an equal number of officers at the higher rates of pay. In 1854 the new Major-generals alone involved an additional charge of £18,000 a year. This description applied before 1854. In that year general brevets were abolished, a fixed establishment of General Officers being substituted. The only brevets now are obtained by service of five years as Lieutenant-colonel (making the officer brevet Colonel without increase of pay); by distinguished service in the field, applicable to Lieutenant-colonels, Majors, and Captains (carrying the substantive pay of the higher rank, except in the case of the Lieutenant-colonel); and by succession, when a death occurs among the establishment of General Officers. In this last case there is no brevet promotion to the rank of Colonel, but the senior Major in the whole army and Marines becomes a brevet Lieutenant-colonel without increase of pay, and the senior Captain a brevet Major with 2*s*. a day extra. Officers become Major-generals, in accordance with their seniority as brevet Colonels, and it will be seen, from the above description, that the brevet rank of Colonel, which is the stepping-stone to Major-general, is obtainable *by service only*.

In the United States army the brevet is a commission giving an officer a nominal rank higher than that for which he has a salary. A great number of these honorary titles were bestowed during and after the Civil War.

BRICHE.—A machine of war used in ancient times to throw stones; now obsolete.

BRICKS.—The earliest examples of this branch of the ceramic art were doubtless the sun-dried bricks of Egypt, Assyria, and Babylonia. Remarkable to say, many of these, which, in a northern climate, the frosts of a single winter would destroy, have been preserved for some 3000 years by the dry, warm atmosphere of those countries. Sun-baked bricks of ancient date are also found in the mud walls of old towns in India. Kiln-baked bricks must have been the products of a later time; but they are found in all the chief ruins of ancient Babylonia, where they were often used to face or bind together walls of sun-dried bricks, and occasionally they were even ornamented with enameled colors. Burnt bricks were employed in the foundations of the Tower of Babel (Gen. xi. 3). These ancient bricks, whether baked by the sun or by fire, were all made of clay mixed with grass or straw. The ancient Greeks, probably owing to their possessing plenty of stone, cared little for building with burned clay; but most of the great ruins in Rome are built of brick, and the Romans appear to have introduced the art into England. Interesting historical information has been obtained from the impressions on Roman and especially on Babylonian bricks. In many instances the Roman bricks found in England have been removed from their original position, and employed in the construction of buildings of later date. The earliest instance in which bricks of the modern or Flemish make occur in England is Little Wenham Hall, in Suffolk, 1260.

Clay suitable for the manufacture of common bricks is an abundant substance, but there is a great difference in the nature and quality of the clays found in various localities. The basis of clay consists of hydrated silicate of alumina, with a varying proportion of other mineral matters, chiefly free silica (sand), iron, lime, magnesia, and potash. Great advantage is derived from digging clay in autumn, and exposing it all winter to the disintegrating action of frost. This is not always attended to, but when neglected the bricks made from it are apt to be unsound,



Brick-making Machine.

and faulty in shape. The next process is that of tempering or mixing the clay into a homogeneous paste, which is sometimes done by the spade, but more commonly in the pug-mill (at least in England), or by crushing between a pair of rollers; often, indeed, both are employed. In making bricks by the old hand process, the shape is given by a mold either entirely of wood, or of wood faced with metal, and without top or bottom. This admits of the clay being pressed into it by a tool called a plane, which is also used to produce an even surface on the upper and lower beds of the brick, by working off the superfluous clay. Sand is used to part the wet clay from the mold and the table on which it rests.

Although hand-made bricks are still very common, yet machinery is now always employed when large quantities are required. Brick-making machines are of two leading kinds; one class of them being constructed to work the clay in a wet plastic state, the other class requiring it to be in a semi-dry condition. Of the two sorts, the wet-clay machines are the simpler, cheaper, and can be worked by less-skilled workmen. On the other hand, the dry-clay machines, which make the bricks by forcing the clay into molds by strong pressure, shorten the process, as no time is required for drying them. The bricks so made, too, are not only of a more perfect shape, but they can be molded into any form, and may even be made highly ornamental at a very slight additional cost.

One of the best-known brick-machines is that which bears the name of the inventor, Martin, and is represented in the drawing. It is automatic in its construction, grinds and tempers its own clay, and is particularly adapted to the working of hard and heavy clay. It does its own molding, and delivers the bricks in front, ready for the carrier to place them on the yard. The molds are delivered by the power of the machine while the press is on; therefore it does not draw up the bricks while delivering, but molds them stiffer than any other machine, and delivers them with good, square corners and well-defined edges. The lever connected with the haul-out is arranged with a movable center, held by a friction-pulley, so that, should any stone or hard substance get into the mold, or the mold be in any way obstructed, the lever simply moves forward, giving time to remove it without stopping the machine, and preventing the breaking of molds or any part of the machinery. Then, by raising the small lever connected with the friction-pulley, the center moves back, and the machine operates as before. The capacity of the steam-power machine is 4000 bricks an hour, and the horse-power 2500, although in many instances it has largely exceeded that number.

The green bricks, after being carefully dried, either in the sun or by artificial heat, are usually baked in a kiln with a suitable arrangement of fires and flues. Kilns are of many forms, and the time required for firing in them varies from 40 to 60 hours for common red and white bricks, while for some fire-bricks 150 hours are necessary. Where kilns are not used, bricks are burned in clamps, the clay requiring to be mixed up, in the process of tempering, with a quantity of ground coal sufficient to burn them. A good test of the character of a clay is obtained by the result of firing. The average contraction in the kiln for prepared clays is 7½ per cent. If a brick contracts much more than this, the clay is too fusible; if less, then it is likely to be of an open porous body, which retains its shape well during the firing process. All brick clays contain iron, and the color of a burned brick almost entirely depends on the amount of it which is present; thus clays containing less than 1 or 1½ per cent of iron change in the kiln to various shades of cream-color and buff, whilst those containing more than 2 per cent range in color from yellowish fawn to dark red. Blue bricks are made from the same clay as the red, by controlling in a peculiar way the supply of air in firing, and by carrying the heat slightly further. It is asserted by some that the red is changed to the black oxide of iron in the process. Fire-bricks are made from clay as free as possible from oxide of iron and alkaline substances, so that there may be no tendency to fuse in the kiln, however high the heat. Fire-clays are abundant in the coal-measures, some of fine quality being found about Newcastle and Glasgow, but the most celebrated is that of Stourbridge, which is exported to all parts of the world.

Mortar composed of lime and sand is the common cement for brickwork. It should be equally and carefully applied; and the bricks wetted, in order that the mortar may adhere more firmly, by being absorbed into their pores. The force with which good mortar is capable of adhering to bricks is very remarkable. It is found to be the greatest in old structures that have been exposed to the continuous action of water. Such bricks are said to be "water-bound" by workmen, and can scarcely be separated without breaking the bricks. A fundamental principle to be rigidly observed in laying all kinds of brick is, that *no two con-*

tiguous perpendicular joints shall fall immediately below each other. The mode of arrangement of the bricks to effect this is called the *bond;* a layer or stratum of bricks is called *a course.* Bricks laid with their lengths in the direction of the course, and their sides to the wall-face, are called *stretchers;* those laid across the line of the course, with their ends forming the wall-face, *headers;* a layer of headers, a *heading course;* of stretchers, a *stretching course.* The two kinds of bond almost exclusively used in England are the English and Flemish bond. English bond consists of alternate stretching and heading courses; Flemish bond, of a stretcher and header laid alternately in each course. English bond is the strongest; Flemish bond, the more ornamental; and they are used accordingly. There are two other kinds of bond occasionally used—*herring* bond and *garden-wall* bond. The former is applied to form the core of thick walls, where Flemish bond is used for the facing. A course of bricks is laid obliquely at an angle of 45° to the face of the wall; then above it another course at the same angle, but inclined in the opposite direction, so that the joints may cross the first. This is considered to add to the strength of Flemish bond, but is objectionable on account of the triangular interstices necessarily left between the oblique bricks and the bricks of the facing. Garden-wall bond is only used for 9-inch walls, and formed by laying three stretchers and one header, and so on in each course. In order to strengthen Flemish bond, bands of hoop-iron are sometimes laid flatwise between the courses. This "hoop-iron bond" has superseded the old practice of using bond-timbers, which were inserted the whole length of the wall. The hoop-iron should be slightly rusted, to secure the complete adhesion of the mortar.

In constructing arches of brickwork much care and skill are required. A wooden centering is always used; and when very rude work only is required, common bricks are laid upon the centering, and the gaping interstices at the upper ends filled with rough brick wedges. For better work each brick has to be properly beveled, according to the curve. When semicircular arches are made, all the bricks require an equal bevel, and therefore bricks molded uniformly to the required angle may be used; but for other curves, and for flat arches, each brick has to be separately shaped by the bricklayer. In order to do this, a drawing of the required arch is made of the full size on a board; the bricks are laid upon this side by side, and shaped to the lines of the drawing; they are then transferred to their corresponding place in the structure. The bricks are first rudely shaped by the *brick-axe*, then finished on the *rubbing-stone*, a piece of rough-grained stone about twenty inches in diameter. In all kinds of brick, the walls should be built up level throughout, in order that the *settlement* may be equal. An unequal settlement may produce a rupture of the wall.

BRICOLE.—An improved kind of traces used by the French in drawing and maneuvering artillery; analogous to the old drag-rope, but having the addition of a leather strap or girdle with a buckle, to which the drag is affixed, and an iron ring and hook at the end to drag by.

BRIDGE.—In gunnery, two pieces of timber which go between the two transoms of a gun-carriage. Not used in the United States service. See *Bridges.*

BRIDGE-CRANE.—Cranes of this type are designed for operation by hand or power. As constructed for general yard-use, a bridge-crane consists of a stationary bridge, supported at each end by a suitable trestle, and provided with a trolley moving transversely on the bridge. The load is carried by a running block suspended from the trolley, and the mechanism for hoisting and traversing is attached to one of the vertical frames or trestles near its foot. Cranes of this construction are built of capacities of from 2 to 12 tons for operation by hand, and of any desired capacity for operation by power. There is another form of bridge-crane, in which one end of the bridge is supported by a building and the outer end by a frame or trestle, so that the frame is available for transferring weights into or out of the building. In some cases a crane of this type is placed between two adjoining buildings, its ends being supported by the adjacent walls of each building; while in other cases the bridge of the crane is carried through the doorway of a building, so that the load can be transferred from a truck or car outside of the building to some point within it. When arranged for operation by hand it is built entirely of iron, and is provided with mechanism substantially identical with that of the jib-crane, to which reference is made for further particulars. The same mechanism is utilized for hoisting and lowering at several speeds, and for causing the trolley to travel upon the bridge. When arranged for operation by power the operating mechanism is located within the building, and driven by power taken from the line shafting. The levers for controlling the several motions are placed upon the wall of the building at any convenient point within, and arranged so that they may be used from either of the several floors. The operating mechanism is substantially identical with that employed in the power traveling-cranes. Cranes of this type are available for yard-uses of all kinds in connection with foundries, machine-shops, quarries, etc. They are particularly available for loading and unloading heavy artillery from cars, and are an excellent substitute for the pillar-crane. As compared with the latter they have the advantage of not requiring any foundation except that necessary to resist the direct pressure due to the load. They may be made to span two or more tracks and are thus available for transferring loads from one car to another, or from a car to a truck or platform. See *Cranes* and *Rotary Bridge-crane.*

BRIDGE-EQUIPAGE.—The United States bridge-equipage is composed of two distinct trains,—the reserve and the advance trains. The former is intended to accompany large bodies of troops in the field, and is provided with the material for the construction of bridges of sufficient capacity to pass large armies with their heaviest trains over rivers of any size and capacity. For these the French ponton is adapted. The advance-guard train is intended for the use of light troops, such as advance-guards, cavalry expeditions, etc. It is organized, both as regards material and carriages, with a view to rapidity of movement. At the same time it is capable of furnishing a bridge which will fulfill all the requirements of troops engaged on such service. For this train the canvas ponton is adapted. See *Bridges.*

BRIDGE-HEADS.—The works planned for the defense of a river will depend on the object to be attained, whether it be simply to prevent the enemy from crossing, or to give the assailed the means of a secure communication with the opposite shore.

The points most favorable to the passage of the enemy are fords; and when the river is not fordable, the points where an elbow is formed, the re-entering being towards the enemy. To guard these weak points, works should be placed in a suitable position to prevent the enemy from approaching the opposite bank; and in the case of a ford, every obstruction should be accumulated on these, and the plan of the works should be so arranged that their fire can be concentrated on the ford; and, if the assailed have cavalry, a free space should be left between the water and the works for the cavalry to act on; the object being to charge the enemy whilst crossing the ford in disorder.

To keep open a free communication with the opposite shore, it will be necessary to throw up works there of sufficient strength to allow the assailed time to effect a safe retreat, should they be attacked by superior forces. As these works serve to cover the bridges in the rear, they are termed *têtes-de-pont*, or *bridge-heads.* The best points to erect a bridge-head are the bends, or elbows of the river, the re-entering being towards the assailed. The reasons for selecting these points are that the bridge-head may be protected by a good flank and cross fire from the opposite shore, which from its shape is most favorable for this purpose; secondly, from the manner in which elbows are formed, the point occupied by the bridge-head will commonly be commanded by the opposite shore, and should the enemy succeed in obtaining possession of the bridge-head, he will have all the disadvantages of a commanded position; thirdly, the elbow is not only unfavorable to the enemy, by preventing him from placing a battery in a position to destroy the bridge, but it also may prevent floating bodies, thrown into the current by the enemy with the same view, either by their shock, or by fire, from coming directly in contact with the bridge, as the chances are that those bodies will strike one or the other shore before reaching the bend.

The plan of a bridge-head should be carefully studied on the ground; and it should, as far as practicable, satisfy the following conditions: 1. Admit of a defense until all the troops have effected a safe passage. 2. Cover the bridge from the enemy's artillery, so that the retreat may not be cut off by the destruction of the bridge. 3. Be suited to the end in view; if, for example, its object is to afford the means to small detachments of making incursions on the opposite shore, a small unimportant work will be all that is required; but if a large corps is to pass, either in retreat or to act offensively, then the works should be arranged with wide intervals, to allow the troops to debouch in mass, and display readily in order of battle. 4. The flanks of the works should rest upon the banks, to prevent their being turned; and, when practicable, they should be protected by flanking arrangements from the opposite shore. 5. A strong interior redoubt should secure the bridge against an attempt on the part of the enemy to obtain possession of it by storming the works.

The practicability of obtaining flanking arrangements from the opposite shore will materially affect the plan of the bridge-head. If the breadth of the river is over one hundred yards, not much reliance can be placed on a flanking arrangement for musketry; and if the breadth is from 600 to 800 yards, it will still admit of a very effective flank fire of artillery, but not greatly beyond this. For an unimportant work, therefore, which can be flanked by musketry from the opposite shore, a redan or a lunette will be a very suitable form; and if the work can only be flanked by cannon, a priest-cap, as shown in Fig. 1, or a redan, with *crotchets*, or flanks, near the extremities of the faces, and perpendicular to them, arranged for musketry, will be a very suitable form. Neither of these works, however, admits of sufficient strength to cover a very important point, whose loss might compromise the safety of an army or the success of a campaign. The best arrangement for this purpose is either a *horn-work*, shown in Fig. 2, or a *simple* or *complex crown*. The horn-work, like the priest-cap, is best adapted to a position where the shore for some distance is nearly a straight line. It consists of a bastioned front nearly parallel to the shore and at a suitable distance from it to give the work sufficient interior capacity, and of two wings which close the flanks. When the flanking from the opposite shore is inefficient, a crotchet is added to each wing to defend its ditch and sweep in flank the approach to it. This work is only suitable where a large detachment holds the point it defends.

The simple crown consists of a central bastion, and two half-bastions near the banks. In planning this work, the banks which protect the central bastion should be longer than the other two, as it is hardly probable that the enemy will attempt an attack on any other point but the salient. The batteries on the opposite shore should sweep the ground immediately in front of the faces, and cross their fire in advance of the salient. The complex crown-work consists of a polygon of three or more sides, on each of which a bastion-front is constructed. If the bridge-head is to cover the maneuvers of a large army, either advancing or retreating, a strong simple crown, with a system of detached lunettes, about 600 yards in front of it, presents a very suitable arrangement. The lunettes may be arranged as in the system of General Rogniat. The central bastion of the crown-work should be armed with a strong battery of heavy guns to protect the lunettes; and heavy batteries, on the opposite shore, should sweep the ground between the lunettes and crown-work. If there are islands in the river near the works, they may be fortified with advantage to flank them. Besides the arrangements already mentioned, intervals of from ten to twenty yards should be left between the shore and the works, for the troops to defile through; the interior is covered by a traverse in rear of the interval. A small defensive stockade should be formed immediately at the head of each bridge, to enable a company of picked men to defend it until the bridge can be cast loose from the shore. An interval of at least 100 yards should be left between the bridges, if more than one is used, and about the same distance should be left between each bridge and the wings of the work. There are no works that demand more care in their plan and construction than têtes-de-pont on important points. They should receive a strong profile so as to command all the approaches, and be flanked, so as to render an open assault impracticable.

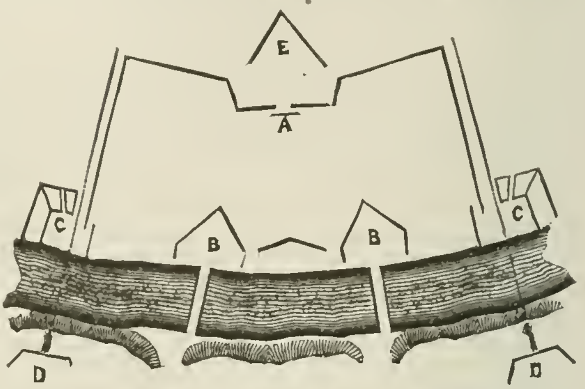


Fig. 2.—Plan of a Horn-work Tête-de-pont. A, Traverse to cover outlet in the curtain; B B, Stockade head of bridge; C, Outlets on the Flanks; E, Redan covering Outlet at A; D, Batteries.

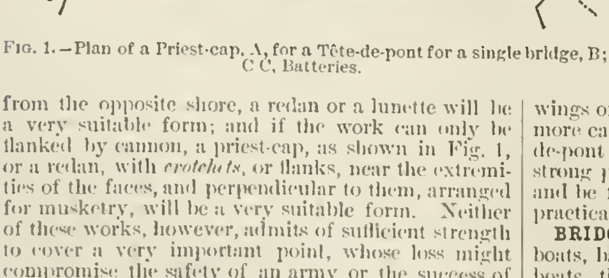


Fig. 1.—Plan of a Priest-cap, A, for a Tête-de-pont for a single bridge, B; C C, Batteries.

BRIDGE OF BOATS.—A military bridge formed of boats, barges, etc. As there are a variety of shaped boats, there are many rules for their construction, taking into consideration the species of rivers to be bridged, the pressure of the water, etc. In India, bridges of boats are generally formed from the boats of the country. They are united to each other at a distance of about 6 feet, and anchored; they are then connected by planks and thus afford a safe passage.

BRIDGES.—An army moving forward oftentimes finds its march interrupted by a large stream or river, intersecting the general line of advance. The army may be crossed over either by fording, by ferrying, or by bridging the stream. Which of these methods should be adopted will depend upon the depth of the stream, its width, the character of the bottom, the strength of the current, and the means at hand.

When wishing to cross a narrow but deep and rapid river, on the banks of which trees grow long enough to reach across, one or more should be felled, confining the trunk to its own bank, and letting the current force the head round to the opposite side; but if the river be too wide to be spanned by one tree—and if two or three men can in any manner be got across—let a large tree be felled into the water on each side, and placed close to the banks opposite to each other, with their heads lying up-streamward. Fasten a rope to the head of each tree, confine the trunks, shove the heads off to receive the force of the current, and ease off the ropes so that the branches may meet in the middle of the river, at an angle pointing upward. The branches of the trees will be jammed together by the force of the current, and so be sufficiently united as to form a tolerable communication, especially when a few of the upper branches have been cleared away. If insufficient, toward the middle of the river, to bear the weight of men crossing, a few stakes, with forks left near their heads, may be thrust down through the branches of the trees to support them. Fig. 1 shows the positions of three trees, *a*, *b*, *c*, judiciously selected and felled so as to have their tops unite in the current at *d*.

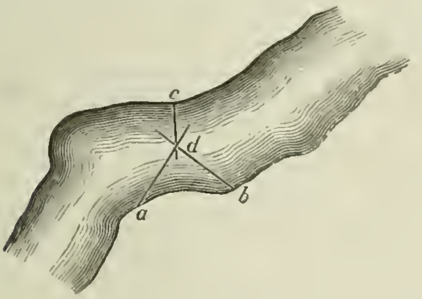


FIG. 1.

When a river which cannot be forded must be crossed by animals and carriages, a bridge becomes necessary; and in all cases it is better, if possible, to cross by a bridge than by a ford, unless the latter be exceedingly shallow. Military bridges may be of three kinds: 1st. Fixed structures of timber. 2d. Floating-bridges. 3d. Flying-bridges. Timber bridges may be either supported on piles or on trestles. Pile-bridges are the most secure, and where bridges are required to remain in use for a considerable period, as those which may be constructed on the lines of communication of an army, with its base of operations, this form of bridge will generally be adopted. To construct a good pile-bridge over a considerable river much skilled labor is necessary, and an ample supply of materials essential. When the bottom of the channel is firm, and the river not subject to floods, a pile-bridge may be constructed without difficulty, and will be very durable. The piles must be driven by an engine, which may be constructed of an 8-inch or 10-inch shell run full of lead, suspended by a rope over a pulley. This may be worked by hand, and will drive piles to a depth sufficient to allow of the passage of the heaviest artillery over the bridge. The pulley of the pile-engine should be supported on a framework some 16 feet high, which may be made to act as a guide to the shell during its fall, and also for the pile while it is being driven. This framework should be erected upon a large flat-bottomed boat. If such a boat is not to be procured, a raft must be made to answer the purpose. When timber of a considerable length can be procured for the joists of the bridge, it will be advisable to make the intervals between the piers or rows of piles as great as the length of the joists will allow, so that the current of the river may be impeded as little as possible, and its action on the bridge be reduced to a minimum. By this arrangement, too, as much space as possible is given for the passage of floating bodies, and the danger of their damaging the bridge is proportionately diminished. When all the piles have been driven as far as the power of the engine can accomplish, they must be sawn off to the same level, and the superstructure of timber be strongly and carefully fitted. With bays of 20 feet and a roadway 14 feet wide, there must be at least five or six beams not less than 7 inches by 8. With wider bays, timbers of larger dimensions will be necessary. The planking should not be less than 2 inches thick, laid transversely. Bridges on piles, for the passage of infantry over shallow rivers only, may be expeditiously constructed, as the piles may be slight—6 inches in diameter would suffice—and they can be driven by hand by heavy mauls, or by two men using a beetle. Here the pile is set and kept in its place by means of two spars of planks resting their extremities upon a stool placed on the bank. A plank is then laid across, on which one or two men may stand to drive the pile. The weight of the men may be increased, if necessary, by stones placed on the platform assisting to force the piles into the ground. When one row of piles is placed, and the floor laid to a cross-beam fixed upon them, another row may be set and driven in the same manner, fixing the stool on that part of the floor which will thus have been completed. Piles driven in this way may be safely depended upon to bear infantry with a front of two or three files in open ranks, not keeping step.

When rivers are shallow and not liable to sudden floods, and when their channels are firm and even, very useful bridges may be constructed on trestles. Trestles for this purpose should each consist of a stout transom or ridge-piece some 8 inches square and 16 feet long; to this should be fitted four legs adapted to the depth of the river slanting, outward from the vertical, and strengthened by diagonal bracing. For large bridges it will be found advantageous to add an additional pair of legs to each trestle. These, from the difficulty of fitting six legs to the uneven surface of the bottom of the river, should not be attached until the trestle is placed in position; they should then be driven into the bed of the river, and their upper extremities should be firmly nailed to the ridge-piece. When the different parts of the trestles are all prepared beforehand, they can be speedily put together and the bridge completed with great expedition. Fascines may be used for flooring where plank cannot be obtained. If there be a strong current, a cable should be stretched across the river on each side of the bridge, and the trestles be firmly lashed to them. It may, moreover, sometimes be necessary to load the trestles with shot or stones, to keep them in their position until the flooring is laid upon them.

Boats of almost any kind will make a serviceable bridge. For wide rivers the boats should be large. The boats of which a bridge is constructed should, if possible, be nearly of the same size, unless they are all very large, and then variations in dimensions will be of little consequence. Should some be large and some small, the passage of large bodies of troops, of heavy guns and ammunition-wagons will depress them unequally, causing the flooring of the bridge to assume an irregular line, straining and injuring, and in some cases fracturing, the timber and destroying the bridge. When boats all of the same size cannot be obtained, the larger boats should be placed at wider intervals, so that they may sustain a heavier weight, proportioned to their greater capacity, during the passage of troops, and be depressed to an equal distance with the smaller. The superstructure will consist of balks of timber laid across the gunwales of the boats, and securely fastened, and the flooring of planks laid transversely over. A certain rigidity results from this arrangement, by which, if the boats were subject to much motion, the bridge would be speedily destroyed. In tidal rivers, where a considerable swell must generally be encountered, this manner of securing the timbers will not answer. In this case it will be found advantageous to erect a trestle or support in the center of each boat, over which the timbers may be bolted to each other: thus each boat will be allowed independent motion, and this will not endanger the fracture of the bridge. The boats should be moored head and stern, and should be kept at their relative distances by timbers fixed at the head and at the stern, stretching across the bays, so as to remove unnecessary strain from the timbers of the bridge. The timbers should be as nearly as possible square, and of dimensions proportioned to the space of the intervals. With good timbers, 8 inches by 6, 20 feet may be allowed from trestle to trestle. The width of the bridge should also be proportioned to the dimensions of the timbers. With five balks of 7 inches by 8, the bridge should not exceed 14 feet in width. If too wide there will be danger of the beams being broken by the overcrowding of troops on the bridge.

When there is no regular ponton-train, and boats cannot be procured, rafts may be used in place of

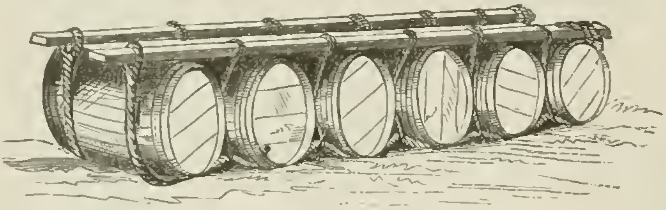


FIG. 2.

boats. These rafts may be made of *casks*, which, if properly arranged and securely lashed, will answer all the purposes of pontons. To make the raft, the casks are placed in a row, side by side, with the bungs up; two rails or saplings called gunnels are laid along them about four inches from each end. Slings of strong rope are passed under the casks, from end to end of the gunnels. The ends of the sling should be made fast to the gunnel, by means of the *bowline* and *fisherman's bend*. Between the casks there are brace-lashings, as shown in Fig. 2. In the absence of sufficient rope the gunnels must be nailed or spiked to the casks; but the use of nails or spikes in rafts or floating bridges is to be avoided when possible, as they admit of insufficient play. To determine the number of casks required to construct a raft that will support N pounds, find the solid contents of one cask in cubic inches and multiply it by the specific gravity of water. From the product subtract the weight of the cask; the remainder will be the weight it will support without sinking. Take a sufficient number of casks to bring this weight up to N pounds.

Unfordable streams may be readily crossed by means of flying-bridges or rafts, when there is sufficient current and when ropes and timber are handy. The flying-bridge or raft may be successfully navigated by attaching it to a swinging cable made fast up stream, or by making it fast to a traveler running on a cable stretched across the stream. In the first case, the lower end of the cable should terminate in a bridle. On leaving the shore, the end of the bridle farthest from it is gathered in, while the other one is slackened, and the raft shoots across the stream. To re-cross, the end of the bridle farthest from the shore is hauled in and the other again slackened. The same may be effected by means of rudders as shown in Fig. 3, the cable being made fast to the raft about one third of its length from the bow, while it is kept headed obliquely up stream. The principle of action in this case is the same as that of a kite in the air. In the second case, the cable stretched across the stream must be carefully secured when the current is great. The maximum pull of the raft will be SV^2, in which S is the area of the immersed side of the raft in square feet, and V the velocity of the current in

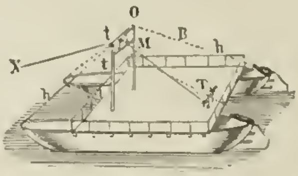


FIG. 3.

feet per second. To insure proper progress, the velocity of the current should not be less than two miles per hour. Referring to Fig. 4, the component of the force of the current which tends to force the raft directly across the stream may be readily traced. If the raft is kept on the course MN, and the current is running in the direction AX, it is plainly seen how such a force, AB, is divided into two components, AC and AD, acting parallel and perpendicularly to MN. The component AD is again subdivided into two components, AE and AF, acting parallel and perpendicularly to AX. DE = AF is the component of the power of the current tending to force the raft across the stream. To produce the best effect, the side of the raft should be kept at an angle of 55° with the direction of the current, or BAC = 55°. The cable may be taken across the stream by a swimmer, or by means of a lobstick—made by splitting a stick, inserting a rock or pebble, and lashing the stick with twine. A small line is first made fast to the cable, the end of which is sent across; whereupon the end of the cable is drawn over. Under certain circumstances, the small line may be sent over by means of an arrow, rocket, or kite.

The mountain streams, during the seasons of high water, remain above the fording-stage for several weeks, and often render it necessary, when time is an important element, to cross them by swimming or ferrying rudely-constructed boats or rafts. Timber rafts may be quickly constructed in a wooded country. The size and description of the timber must determine the number of layers there should be. The cubic contents, in feet, of round timber = L ($G^2 \times .07958$), in which L = length of the log in

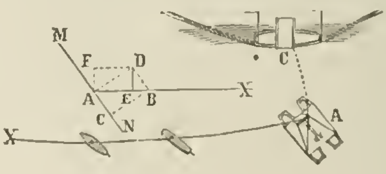


FIG. 4.

feet, and G is the mean between the girths at both ends in feet. The floating power of any log may be readily calculated when the specific gravity of the wood is known. The raft of logs has little buoyancy, wants general manageability, and is inapplicable when the passage of a river is likely to be contested with animation. Its merits are that, at the expense of time, it can be constructed with less experienced workmen; it saves carriage, as it can only be made of materials near the spot. It is, however, an indifferent substitute for boats, pontons, or casks. An independent raft will require two rows of trees, at least, to float as many men as can stand upon it, and the logs are best bound together by withes or ropes, and stiffened with cross and diagonal traces.

As shown in Fig. 1, large trees may be felled to enable infantry to cross narrow streams, placing them so that their butts may rest upon the banks with the tops directed obliquely up the stream; if one is not long enough, others may be floated down so as to extend across, being guided and secured by ropes: a footway may be formed by laying planks, fascines, or hurdles over them, and their branches should be chopped off nearly to the level of the water and intertwined below; poles also may be driven into the bed of the river, to aid in supporting the trees by attaching the boughs to them. *Wheel-carriages* used to form a foot-bridge may be connected by beams; or a single pair of wheels with an axletree to admit two strong posts may be attached and placed in the center of the stream if it is not too wide. Poles reaching from each bank may be secured to the posts, and the wheels would act as a trestle. With a flooring over the poles, a slight bridge could be rapidly constructed for an advanced-guard. *Hide boats* are made of four buffalo-hides strongly sewed together with buffalo-sinew, and stretched over a basket-work of willow or cottonwood 8 feet long and 5 feet broad, with a rounded bow, the seams then being covered with ashes and tallow. Exposed to the sun for some hours, the skins contract and tighten the whole work. Such a boat with four men in it draws only four inches of water. *Inflated skins* have been used since the earliest times for crossing, and if four or more are secured together by a frame, they form a very buoyant raft. *Canvas* (rendered water-proof by a composition of pitch 8 lbs., beeswax 1 lb., and tallow 1 lb., boiled together and laid on quite hot) will serve as a raft or ponton, if placed over framework or wicker work. See *Military Bridge* and *Ponton*.

BRIDGE-TRAIN.—A bridge-equipment or ponton-train, consisting of a military bridge composed of portable boats.

BRIDLE.—An instrument with which a horse is governed and restrained, consisting of a head-stall, a bit and reins, with other appendages, according to its particular form and uses.

BRIDLE-ARM PROTECTOR.—The term for a guard used by the cavalry, which consists in having the sword-hilt above the helmet, the blade crossing the back of the head, its edge directed to the left and turned a little upwards, in order to bring the mounting in a proper direction to protect the hand.

BRIDLE-BIT.—Bridle-bits are of great antiquity, as is proved by the Egyptian and Assyrian paintings and sculptures. Xenophon (400 B.C.) describes several kinds, smooth, sharp, and toothed. The curb is a modern invention, and was introduced into England from the Continent in the reign of Charles I. Etruscan and Grecian sculpture represent the bridle substantially as we yet have it. The Greeks had a severe bridle, armed with teeth, which came over the nose like the *cavezon*, a European bit but little known among us. Another rough bit was also known as a *lupaton*, owing to its sharp prongs like wolves' teeth. Bridle-bits may be classed under three heads: *snaffles*, *curb-bits*, and *stiff bits*. The snaffle has two bars, jointed together in the middle of the mouth, and has rings at the ends for the rein. It sometimes has cheek-pieces, to keep the ring from pulling into the mouth of the animal. The curb-bit consists of the *cheek-pieces* or *branches* with eyes for the *cheek-straps* and for the reins, and holes for the curb-chain; a *mouth-piece*, uniting the *cheek-pieces* and forming the bit proper; sometimes a *bar* uniting the lower ends of the branches; and a *curb-chain*. In the Mexican bit, the curb-chain and its strap are replaced by a curb-ring. By means of the branches of a bit a leverage is obtained upon the horse's jaw, the curb-chain behind the jaw forming the fulcrum. The Whitman bit with snap-hook attachment, used in the United States army, is to be commended for its lightness, elegance, economy, and, above all, strength. It combines the common riding-bit and bradoon-bit in one, makes it easier for the horse, and at the same time invests the rider with a greater control over the horse than by means of other bits. With a proper halter this bit only requires a pair of reins and curb to form a perfect bridle. A large number of contrivances have been patented for giving a greater command over the horse, by means of pulling the bit upward into the angle of the mouth instead of pulling against the jaw.

BRIDLE-REIN.—A rein passing from the hand to the bit, or from the check-hook to the bit; or, in wagon-harness, from the top of the hames to the bit. The bridle-rein may be a *check*-rein, *gag*-rein, or a *riding-bridle*-rein; the latter a *snaffle* or curb-rein, according to the kind of bit.

BRIDOON. The snaffle-bit and rein used in European military equipments in connection with a curb-bit which has its own rein. In the United States the term is sometimes applied to a simple snaffle without cross-bars, and having a rein attached to its rings.

BRIGADE.—In the military service a brigade is a group of regiments or battalions combined into one body. When a British army takes the field, it is customary for three battalions to form a brigade, and two brigades a *division*. Thus, at the battle of the Alma each of the five divisions of British infantry comprised two brigades; and of these ten brigades, nine consisted of three battalions each, the tenth being somewhat stronger. It is nothing more than a temporary grouping, which can be broken up whenever the Commanding Officer thinks fit. The Household Troops, comprising the Horse-guards, Life-guards, and Foot-guards, are sometimes called the *Household Brigade*.

In the United States army the brigade may be formed in one or two lines. The distance between the lines varies both with the nature of the ground and the state of the action. If on the offensive, the second line is held at close supporting distance; if on the defensive, it is held at sufficient distance in the rear to enable the first line to reform behind it, and to prevent the enemy from passing over it with the first line, should that line be driven back. Battalions are designated from the right when in line, and the head when in column, *first battalion*, *second battalion*, and so on. If in two lines, the battalions of the first line are designated from the right *first* and *second*; those of the second line, *third* and *fourth*. If in two columns, the battalions last in the front line are designated from the head of the column *first* and *second*; those of the second line, *third* and *fourth*. These designations change whenever, in facing to the rear, the left of the line becomes the right, and the rear the head of the column. The battalion movements incident to the commencement and completion of all brigade evolutions, the advance in line, and all movements in double time, are executed in the cadenced step. The remainder of the time, unless otherwise ordered, each Colonel marches his battalion in the route-step. When not in the route-step, Colonels cause their pieces to be carried habitually at a *right shoulder*. The brigade is formed on the principles of successive formations, and is presented to the General by the Adjutant-general, as explained for the Adjutant of a battalion, the Colonels repeating commands. The General takes post, facing the line, about seventy yards in front of its center.

At forms of ceremony the pioneers are posted twelve yards to the right of the first battalion, the band twelve yards from the right of the pioneers. In the evolutions the band, and the regimental bands, take any position prescribed on the parade-ground. In line of battle, composed of several brigades, the Generals of brigade place themselves about seventy yards in rear of the centers of their brigades. In column, they hold themselves at the heads of their brigades. In brigade evolutions, the General goes wherever his presence is necessary. The General is attended by his personal Staff; the Adjutant-general riding on his left, his Aides-de-camp in rear, the senior on the right. On the march, the remaining members of his Staff march according to rank in rear of the Aides-de-camp, the senior of each rank on the right.

The Colonels, unless otherwise directed, repeat all the commands of the General. Each preparatory command of the General is repeated as soon as it is given; the last preparatory command having been repeated, the Colonels at once add such commands, and execute such movements in their battalions, as may be necessary before the general movement. The General looks to the prompt execution of these preparatory movements, and rectifies every error that may be committed by the Colonels. The Lieutenant-colonels and Majors repeat the general commands, and the commands of execution, as often as the wind or noise of arms may prevent them from being easily heard from one battalion to another.

In successive formations, the line of battle is determined by Staff-officers, three in number, in the following manner: The first officer, at the preparatory command of the General, posts himself at the *point of rest* for the first battalion, facing in the direction the line is to extend; the second posts himself, facing the first, at the *point of rest* for the second battalion; the third posts himself, covering the other two, at the *point of rest* for the third battalion; the first then moves at a gallop and posts himself for the fourth battalion Should there be more than four battalions, the Staff-officer for the second, as soon as the head of this battalion arrives, hastens to mark the point for the fifth, and so on. If the formation be central, the *points of rest* are marked in both directions from the battalion first on the line. In brigade evolutions, successive formations embrace, besides the formation from column into line, *changes of front, formation into line from echelon, and the formation from line into single and double rank.*

In the British service the artillery is divided into two brigades, which consist of seven batteries each, under the command of a Colonel.

BRIGADE DEPOT.—The headquarters of a sub-district of the army. Under the new localization of the British army, the military districts of Great Britain and Ireland are divided into 12 districts, which are subdivided into 70 infantry and 12 artillery sub-districts, and 2 cavalry districts. The infantry sub-districts, as a rule, correspond with the several Counties into which the United Kingdom is divided. In connection therewith the following arrangements have been made: To each infantry sub-district are assigned 2 battalions of Infantry of the Line, one of which is ordinarily at home, and the other abroad. The battalions are linked together for the purposes of enlistment and service. In each infantry sub-district is located a brigade depot under the command of a Lieutenant-colonel, composed of 2 companies from each of the Line Battalions assigned to the sub-district. The Line Battalions, Militia Battalions, the Brigade Depot, the Rifle Volunteer Corps, and the Infantry of the Army Reserve, constitute the infantry sub-district brigade, and the whole, with the exception of the Line Battalion, are under the command of the officer commanding the brigade depot. A Lieutenant-colonel is appointed to each artillery sub-district, and he is invested with the command of the Auxiliary and Reserve Forces of artillery of the sub-district. The cavalry of the Auxiliary Forces is divided, as before stated, into two districts. A Lieutenant-colonel is appointed to each district, who is invested with the command of the Yeomanry regiments and of the corps of Light Horse and Mounted Rifle Volunteers within his district. The regiments of Guards, the 60th Rifles, and the Rifle Brigade are outside the sub-district organization—i.e., they have no special connection with any territorial sub-district. The depot of the Guards continues as at present constituted. The 60th Rifle Brigade have one consolidated depot at Winchester.

The above explains the organization, as laid down by the warrant, for the maintenance of the sub-districts. It is further directed that in exercising authority over the auxiliary and reserve forces, officers appointed to command must remember that these forces have been enrolled under conditions very different from those of the regular army. They must therefore take great care not to exceed the powers conferred upon them by law, and, in exercising the powers which they do possess, must endeavor to carry with them as far as possible the opinions of the Commanding Officers of the Auxiliary Forces. In all cases of doubt, the warrant says, they will do well to refer to the Inspector-general of the Auxiliary Forces. It is ordered in the Queen's Regulations that "a mess shall be established at the headquarters of each brigade depot, which will be credited with one fifth of the contributions of the Company Officers of each Line Battalion belonging thereto, assessed agreeably to paragraphs 32 and 33, as well as with the annual subscriptions of the officers of two companies thereof. The Lieutenant-colonel, the Major and Staff will pay subscriptions only. The two companies of the Line Battalions will bring, on joining a brigade depot, a sum of 50*l.*, for the purchase of such articles of equipment as may be necessary, or in lieu thereof a sufficient amount of mess property." The plan adopted in forming the brigade depots was to associate with the militia of each County certain Line Battalions, selecting as far as possible such regiments as had any connection with the County, besides such volunteers and army reserves as may be in each brigade district. Each brigade has its depot stationed permanently in the district it belongs to; the Line Battalions are moved as the service may require, one being at home and the other abroad; the militia are embodied periodically as heretofore; but all recruits for either branch of the service are intended to pass through the same hands, and to receive their training together. The Cavalry, Artillery, Engineers, Guards, and Rifles are exceptions to these arrangements, and remain not localized.

BRIGADE-INSPECTOR.—An officer whose duty it is to inspect troops in companies before they are mustered into the service.

BRIGADE-MAJOR.—A military officer who exercises duties, in a brigade, analogous to those of the Adjutant of a Regiment. He attends to matters of discipline, and to the personal movements of the men. When regiments or battalions are brigaded, a Brigade-major is appointed, usually from among the Captains. He conveys orders, keeps the rollster or roster, inspects guards and pickets, and directs exercises and evolutions; but he nevertheless remains on the books of a particular regiment, and returns to his regimental duties when the brigade is broken up.

BRIGADIER—BRIGADIER-GENERAL.—An officer in rank next above a Colonel. He commands a brigade. In the British service the Brigadier is an officer of a regiment (usually a Colonel or Lieutenant-colonel), who, for a limited time and for a special service, is placed upon brigade duties. He is then a General or Commander of a Brigade, which usually contains his own regiment as one of the number. When the brigade is broken up, he falls back to his Colonelcy, unless his services lead to his promotion to the rank of Major-general.

BRIGAND.—A species of irregular foot-soldiers, frequently mentioned by Froissart. From their plundering propensities comes the modern use of the term. Sometimes written *Brigans*.

BRIGANDINE — BRIGANTINE. — An article of armor worn during the Middle Ages. It was an assemblage of small plates of iron, sewed upon quilted linen or leather, and covered with a similar substance to hide the glittering of the metal. It formed a sort of coat or tunic. The brigandine was named from the *Brigans*, a kind of light-armed irregular corps, employed something like the Cossacks and Bashi-bazouks of recent days, and, like them, addicted to marauding and pilfering; hence the word *brigand*.

BRINS D'EST.—Large sticks or poles resembling small pickets, with iron at each end. They were used to cross ditches, particularly in Flanders.

BRISE-MUR.—A heavy piece of ordnance which was used during the fifteenth century to batter down walls, etc.

BRISURE.—In fortification, any part of a rampart or parapet which deviates from the general direction.

BRITANNIA METAL.—The present composition of britannia metal at Birmingham is usually 90 tin + 8 antimony + 2 copper, without any zinc or bismuth; although some manufacturers deviate a little from this formula, by adding one or both of the metals last named. The manufacture was begun at Sheffield by Hancock and Jessop, in 1770; it reached Birmingham towards the close of the century, and made gradual progress. At first the articles were made by stamping with dies, and soldering up into form; this being a slow operation, rendered the articles expensive. Afterwards the curious process of *metal-spinning* was introduced; and this, with the subsidiary operation of swagging, rendered a great reduction in price possible. In the spinning process, a thin sheet or piece of britannia metal is placed upon a wooden model shaped like the article to be made; the model is made to rotate in a lathe; and burnishers and other tools are employed to press the yielding metal into all the curvatures of the model. Ductility is an essential quality to the attainment of this end with the metal; how complete it is may be seen in such articles as britannia-metal teapots and dish-covers, the principal forms of which are not given by hammering, stamping, or casting, but by spinning. Besides spinning and swagging, the processes include stamping, soldering, casting, and polishing. When electro-plating was introduced, an increased use of britannia metal arose, as it forms a good ground or basis for the deposited silver. Britannia-metal spoons and ladles, made by casting, stamping, and burnishing, have been nearly driven out of the market by German silver; but the former metal is largely used for many purposes in the laboratory.

BRITISH ARMY.—Like other modern armies, the British army originated in the feudal system. When regal power, tempered by a Parliament, superseded that system, the people, according to their rank in life, were expected to provide themselves with certain kinds of weapons and defensive armor. The Justices of the Peace were empowered to see to these military duties of the people. When the nation was either actually engaged in war, or apprehensive of invasion, the Sovereign issued commissions to experienced officers, authorizing them to draw out and array the fittest men for service in each County, and to march them to the sea-coast, or to any part of the country known to be in most danger. It was in the time of Henry VIII. that Lord-lieutenants and Deputy-lieutenants of Counties were first appointed as standing-officers for assembling and mustering the military force. During the earlier years of the Tudors, contracts were made by the King with "Captains," who undertook to provide, clothe, and feed so many fighting-men for a given money-allowance: but the power intrusted to the Lord-lieutenants gradually changed this system, in relation at least to home-defense. In the reign of Charles I. the important question arose whether the King of England did or did not possess the right to maintain a military force without the express consent of Parliament. This question was all the more bitterly discussed when the King billeted his soldiers on the people. After the troubles of the civil wars and the commonwealth, Charles II. found himself compelled to agree, on his restoration, to the abandonment of all the army except a kind of body-guard or household brigade of 5000 men, sanctioned by the Parliament. In the thirteenth year of his reign he succeeded in obtaining a statute declaring that "the sole and supreme power, government, command, and disposition of the militia, and of all forces by sea and land, and of all forts and places of strength, is the undoubted right of His Majesty; and both or either of the Houses of Parliament cannot nor ought to pretend to the same." Both Charles II. and James II. found, however, to their mortification, that this statute did not in effect give them so much real military command as they had wished and intended—because the Commons, by holding the purse, virtually held the power.

It was in the time of William and Mary that the real basis for the modern British army was laid. The declaration of rights settled, in positive terms, "that the raising and keeping of a standing army in time of peace, without consent of Parliament, is contrary to law." The first Mutiny Act was passed in 1689, to last for six months only; but it has been annually renewed ever since, except in three particular years; and it constitutes the warrant on which the whole military system of England is exercised by the Sovereign, with the consent of Parliament. Since then, with only three interruptions, the Ministers of the Crown have annually applied to Parliament for permission to raise a military force, and for money to defray the expenses. The Sovereign can make war, and can bestow military employments and honors; but the Commons, as the representatives of the tax-paying nation, provide a check on the grasping by courtiers of military privileges. The law on army regulation has been revised, and the British army made the subject of special legislation in the Army Discipline Bill passed in 1879. The great distinction between the British army and that of almost every other State in Europe is that the service is *voluntary*. The subjects of the Crown engage, by free choice, to serve in the army for a definite number of years. In the rare cases where forced service by ballot is obtained, it is in the militia, not the regular army. The British soldier has much hard colonial life to bear, and many long voyages to make; he is, moreover, almost entirely shut out from the chance of being a commissioned officer. As a consequence, the ranks are mostly filled from the more necessitous classes of the community—by those who, from want of steady habits or of education, are the least fitted for industrious pursuits; whereas in France and many other foreign countries the profession of arms is regarded as an honorable one, of which even the private soldier feels proud. Mr. De Fonblanque, comparing the peace establishments of the chief European armies in 1857, found that of England to be the smallest in ratio to population, but the most costly in relation to its strength. The English ratio was 1 in 128; the French, 1 in 95; the Prussian, 1 in 80; the Russian, 1 in 72; the Austrian, 1 in 68. An English private soldier costs the country £52 per annum; French, £36; Prussian, £31; Austrian, £18 10*s*.; Russian, £13 5*s*. The English cost per man is still higher now than it was in 1857, on account of increased attention being paid to the well-being of the soldier.

The British army, in all its completeness, is supposed to be commanded by the Sovereign, assisted by the Secretary of State for War in some matters, and by the Officer Commanding in Chief in others. The component elements are the Household Troops; the Infantry of the Line; the Cavalry of the Line; the Ordnance Corps, comprising artillery and engineers; other bodies of native troops, maintained out of the revenues of India; the Militia; the Yeomanry Cavalry; the Reserve; the Volunteer Artillery and Rifles; and sometimes, during war, Foreign Legions. The "peace establishment" of the British army varies according to the political aspect of affairs abroad, and to the strength of the economizing principle at home. In 1814, when England was engaged in tremendous contests abroad, the regular army reached 200,000 men, exclusive of Fencibles, Foreign Legions, and Militia. In the first few years after the termination of the great war against Napoleon, the reductions in the British army involved the compulsory retirement of no less than 10,000 military officers, who thereupon went on half-pay; these, by filling vacancies, transfers, and deaths, have nearly disappeared. The elasticity which permits the enlargement or contraction of the army arises from varying not so much the number of regiments as the number of battalions in a regiment, of companies in a battalion, or of men in a company. If we compare the strength of the regular army at various periods between 1820 and 1879, we shall find that the actual number of regiments has varied but little, the difference of strength being made up in the three modes just mentioned.

The strength of the British army declined from 1815 to 1835, since which last-mentioned year it has increased. These augmentations have been occasioned partly by the contests in China, India, Kaffraria, Persia, the Crimea, Afghanistan, and Zululand, and partly by a sense of insecurity amid the vast armaments of the Continent. In comparing the strength of the forces at different periods, much confusion is apt to arise from different modes of interpreting the words "British army." This designation may include the whole of the Royal troops in India, whether supported out of Imperial or of Indian revenues; it may include the Militia, the Volunteers, the Yeomanry Cavalry, the Foreign Legions—or it may exclude any one or more of these. The "British army" and the "Military Force of the British Empire" are often treated as convertible terms; to the production of much confusion where actual numbers are given. In the following table, relating to the official year 1879–80, it is shown of what component elements the British army consists. The Militia and the Volunteer Corps are not here included.

	Home and Colonies.	India.		Total British Army.
Horse-artillery	3,131	2,478	=	5,609
Cavalry, including Household Cavalry	12,907	4,312	=	17,219
Artillery	19,225	9,667	=	28,892
Engineers	5,198	428	=	5,626
Infantry, including Foot-guards.	76,366	45,768	=	122,134
Service Corps	2,990	.....	=	2,990
Colonial Corps	2,485	.....	=	2,485
Army Hospital Corps	1,745	.....	=	1,745
Additional force in consequence of reinforcements to Natal	3,900	.....	=	3,900
	127,947	62,653		190,600

Under the column "India" are included only those troops of the Royal army which are *lent* to India, and paid for out of Indian revenues; the other military forces in that region are enumerated under East India Army. Of the total 190,600, 7980 are officers; 16,550 non-commissioned officers, drummers, and trumpeters; and 166,070 rank and file. There are voted for the use of this army 11,325 horses. The total cost cannot well be estimated per head; because, besides pay and sustenance for the soldiers, there are stores and wages for fortifications and military buildings, military weapons and combustibles, and the various kinds of half-pay and pensions. The total expenditure sanctioned by Parliament may, however, conveniently be thrown under four headings, and given in round numbers as follows:

Pay and allowance of combatants	£4,944,200
Auxiliary and Reserve Forces	1,258,500
Stores and works of every kind	6,817,200
Pensions, Militia, Volunteers, etc	2,625,800
	£15,645,700

This is the charge for a *Peace* Establishment, in which to admit of expansion for actual war, the upper ranks (which cannot be summarily created) are disproportionately large.

All the component elements of the army, in *personnel* and *matériel*, and the organization and duties of the troops, will be found noticed under their proper headings. See *Army*.

BRITTEN GUN.—This gun has five shallow grooves, and the projectile is *expanding*, being made of iron, but having a lead envelope and a wooden sabot. The shell loads easily, being less in diameter than the bore; but when the gun is fired, the gas drives the sabot against the envelope and expands the lead into the grooves, so that the shot acquires a rotatory motion. The wooden sabot is now replaced by an iron *shoe-piece*, which is soldered to the soft-metal envelope; it is not liable, like the sabot, to partial separation, and serves to protect the soft metal.

BRITTEN PROJECTILE.—The most novel and valuable part of this projectile is the fastening of a lead ring to an iron shot, by zinc solder, so firmly that the explosion will not strip it off. The process of coating is as follows: The iron projectile is heated to a dull-red heat, dipped in sal-ammoniac, which thoroughly cleans the surface, held for about two minutes in a bath of melted zinc alloyed with antimony, and then placed in a bath of melted lead, hardened with zinc or tin, for three or four minutes. It is finally placed in an iron mold, and lead from the last bath is poured around it. The projectile, thus coated, is squeezed out of the mold by a screw. A wooden plug, usually screwed to the bottom of this projectile, is driven against the lead, and causes it to expand into the grooves. The amount of projection on the ring, as the projectile was formerly constructed, regulated the pressure of the lead against the bore, and was adjusted so as to just stop windage without wasting power or straining the gun. See *Britten Gun*.

BRIZURE.—A term used with Brisé and Brizé, in Heraldry, to indicate that a charge is bruised or broken. See *Rompu*.

BROACH.—A tapering steel tool, of prismatic form, and whose edges are used for reaming out holes. It is particularly used by armorers in enlarging holes in the small parts of fire-arms, etc. When smooth, it is no longer a broach, but a burnisher, and is used for burnishing pivot-holes. The number of sides vary: the smaller the number, the more salient is the edge. The end of a broach has as many facets as the shaft has sides, and the tang is 4-sided.

BROAD ARROW.—The English Government mark, stamped, cut, or otherwise fixed on all solid materials used in Her Majesty's ships or dock-yards, and on government stores generally, in order to prevent embezzlement. The origin of the mark is obscure. Previous to the year 1698, the Naval Authorities prosecuted a dealer in marine stores, for having in his possession certain stores bearing the *broad arrow* of His Majesty. The defendant allowed the evidence against him to go on, and when asked what he had to say, replied that it was *very curious* that the king and he, as a dealer, should both have the same private mark on their property. The receiver of stolen goods was acquitted, and this led to the passing of the Act that persons in possession of naval stores or goods of any kind marked with the *broad arrow*, or other marks therein mentioned, and usually employed in marking naval stores for the navy, shall forfeit all such goods and £200, and also pay costs. The mark is for iron, wood, etc., while the color-thread is for sailcloth and ropes, which enables the Government to identify the smallest piece of such articles.

BROAD-AXE.—A military weapon used in ancient times. Now obsolete.

BROADSWORD.—A sword with a broad blade, for cutting only, not for stabbing, and therefore not sharp at the point, like a saber. It is but little used in the service. This weapon is better known under the name of *claymore*.

BROADWELL RING.—A steel ring fitting into a lodgment called the ring-recess. The pressure of the powder-gas expands the ring against the walls of the bore and the face of the screw-plug, thus preventing the escape of the gas. The French guns of old model had the gas-check fixed to the axis of the breech-plug, but this led to difficulties of working, particularly when using very quick powder, and when the initial velocities become considerable. These guns had two lodgments for the gas-check, the one nearer the breech being reserved for the time when degradations of the bore at the other had occurred sufficiently to prevent a complete closure. This change was very efficacious in prolonging the life of the piece, and only required a shorter axis for the new gas-check. In the model of 1871 only one lodgment is made in the gun; the gas-check is of the same shape, but is placed by hand in the lodgment, and driven up by the breech-screw. It remains in place throughout the firing. The central opening is made of the same diameter as the powder-chamber, and the side is strengthened by a projection. It freely admits the passage of the ammunition. In the large guns the gas-checks are made of copper, and in the small ones of steel. If destroyed, they are easily renewed.

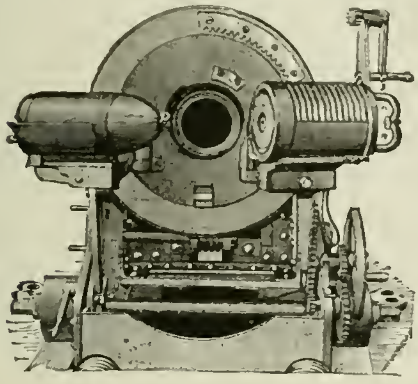


FIG. 1.

The screw-plug is made of steel, and around its circumference is cut a screw-thread, corresponding to the one cut around the screw-box in the tube; the plug and screw-box are reciprocally slotted in three places, so that it can be shoved down to its bearings by hand before engaging the threads. In cutting the slots on the plug, the outer thread is not cut through, and prevents the plug from entering beyond the point where the threads will take each other fairly. The plug is revolved by means of a rack and pinion, one on the end of the lever-handle and the other on the face of the breech. Two turns bring the handle vertical with the blanks on the plug opposite the full threads in the screw-box. The plug is withdrawn from the screw-box, and slides on to a curved bracket hinged to the right side of the breech, on which it is swung around, leaving the breech clear for loading. A bronze bearer, hinged to the other side of the breech, can now be swung around and pushed into the screw-box. This serves to guide the projectile and cartridge clear of the threads, as shown in Fig. 1. On the inner face of the plug a circular nose-plate is fitted, which is held in position by the nose-plate stem which passes through a hole in the center of the plug, and is set up with a screw-nut in the recess of the plug. The vent is axial through the center of the nose-plate stem: there is no vent-check. To obviate the danger resulting from a neglect to screw up the plug when the breech is closed, the lock-laniard, which has a bob on it, is made to pass through the eye, *c* (Fig. 2), of a piece of iron fixed to the breech. When the handle is not in its place, that is, when the plug is not properly screwed in, a spring, *b*, closes the eye and does not allow the bob to pass. When the handle is in position with the plug screwed up, it opens the eye and allows the bob to pass, when the gun can be fired. See *Gas-check*.

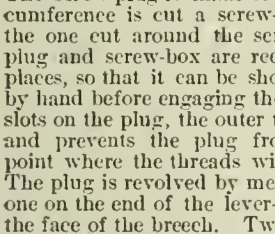


FIG. 2.

BROILING.—A convenient and expeditious mode of cooking small pieces of meat, by troops in the field, by laying them on a gridiron over a bright fire, or even on the coals themselves. This is perhaps the most primitive mode of preparing meat for eating, as may be supposed from the great ease and simplicity with which the operation is managed. Broiling is, in fact, a quicker sort of roasting. The albumen of the outside being sealed up at once, the meat is rendered extremely nutritious, and therefore this process is much to be recommended. But to broil meat so as to preserve its odor, juice, and flavor requires care. The meat should be prepared for the gridiron by being beaten slightly with the rolling-pin, trimmed of superfluous fat and skin, and cut so as to look well on the dish. The fire should be perfectly clear, and of a red-hot surface to answer to the size of the gridiron, that all parts of the meat may be equally cooked. Just before setting the gridiron over, some salt should be sprinkled on the fire to prevent the flare. The gridiron should be perfectly clean and smooth, being always rubbed when it is put away; and, before using, it should be warmed, greased with suet, and rubbed again with paper. When it is placed on the fire, the back should be higher than the front. The meat should never be touched with a fork, but turned rapidly with the broiling-tongs; and when sufficiently done, should be served immediately on a very hot dish, being seasoned according to taste. In large ranges in the garrison there should be a broiling-stove, and an apparatus for broiling suited to it; by this the heat of the fire can be easily regulated. But for all ordinary purposes, a fire of charcoal, or of common coal, and a grooved gridiron to preserve the gravy, are all that is necessary.

BROKE.—The sentence of a Court-Martial depriving an Officer of his commission, or a Non-commissioned Officer or Warrant-officer of his warrant. Also said of a Non-commissioned Officer being reduced by order.

BROKEN LINE OF BATTLE.—A line of battle in which some of the fractions, as brigades, divisions, etc., are separated by the nature of the ground so that it is not practicable to form upon it a continuous line. This arrangement is sometimes known as a line of battle *with intervals*. It follows that in a line of battle of this kind, the different corps or divisions, being separated from each other, cannot give that mutual aid and assistance which is so essential to success. It is therefore an arrangement which is not to be recommended except under peculiar circumstances. When used, it is more generally employed for a defensive than for an offensive battle, and especially under the circumstances where it becomes necessary to give a great extent to the line of defense. Although the fractions on the same line cannot come to each other's assistance, great care is taken to have the reserve so placed that it may have free and easy access to all parts of the line.

BRONCO.—The name applied to the Mexican pony, extensively reared and used west of the Rocky Mountains. The power of endurance of these animals is very great, and they are well adapted to the cavalry service in the rugged and arid country of the Western frontier.

BRONZE.—Bronze is a mixture or alloy of copper and tin. That particular sort of bronze formerly used for guns is often called gun-metal, and consists of about 90 parts of copper and 10 of tin. Bronze is a tough and tenacious metal, but when cast or founded in the ordinary way it is comparatively soft and is easily indented and damaged by the projectile. When heated, as, for instance, by rapid firing, this metal becomes still softer and so more readily damaged. For the small smooth-bore guns formerly used in the field bronze answered tolerably well, as the weight of shot was comparatively small; but with rifled guns using much heavier charges, bronze is not found to be a sufficiently good material. Besides the faults above mentioned, which are inherent to bronze cast in the ordinary way, even when the casting is sound, this alloy has the serious defect of never being quite homogeneous. The tin has a much lower melting point than copper (442° F. as compared to 1800° F.), while its specific gravity is also very different (and although definite alloys can be found, they are not represented by the above proportion, nor such as would answer for gun-metals). While cooling, the two metals forming the alloy seem to separate more or less from one another, the tin liquating or sweating out in parts and causing white spots or blotches called "tin-spots," which are readily acted upon by the powder-gas and eaten away, leaving flaws or holes in the bore of the gun. In rifled guns this defect is much more serious than in smooth-bore pieces, for the grooves cut in the bore lay open a further surface and expose more tin-spots, while the powder-gas acts with greater force (on account of the larger charges and heavier projectiles used), and eats away the spots more quickly. With smooth-bore bronze guns much inconvenience was occasioned by the softness of this alloy, especially when heated by rapid firing; and as experience was gained concerning rifled ordnance in the field, it was found that the defects inherent to ordinary bronze were, as mentioned above, still more serious in such pieces. Their accuracy was affected by much firing, and the greater pressure in the powder-chamber quickly developed flaws by burning out the tin-spots. The cutting of the grooves also laid bare many of these spots, which otherwise would not have been apparent.

Various attempts have been made to discover a modification of bronze, or some analogous alloy, sufficiently hard, elastic, and strong for the purpose required; but as yet, unless the bronze-steel mentioned below be a success, all these attempts have failed. It has also been attempted to improve its quality both in hardness and homogeneity by altering the proportions of the two constituents, and by adding small portions of other metals or non-metals, such as manganese and phosphorus. Phosphor-bronze containing small quantities of phosphorus has been extensively tried, and gives a metal of more uniform character and also stronger than bronze. In 1872 an exhaustive trial was undertaken at Bourges by the French Government with 4-pdrs.; four of these pieces were cast, two being of ordinary bronze and two of an alloy of phosphor-bronze. The superiority of the latter over the guns cast from ordinary bronze was so slight that the Committee carrying on the experiments concluded that any advantages were more than neutralized by the necessity of adding the phosphorus in very exact proportions, and so further complicating the manufacture of bronze guns. Colonel Rosset, of the Italian Artillery, Superintendent of the Arsenal at Turin, has for some years past been carrying on a series of interesting trials with regard to bronze and other metals in the Arsenal at Turin, where a 7.5c. gun of phosphor-bronze was tested in comparison with others of ordinary bronze. This gun stood the trial well, and the alloy from which it was cast (in an iron mold) showed a tenacity of about 25 tons per square inch. Notwithstanding this, however, Colonel Rosset concluded that it was not advisable to employ such an alloy in gun-manufacture on account of the unstable character of phosphorus; and the great difficulty of securing uniformity of result in the mixture of this element with bronze. Russia, too, has been making much advance in the working of bronze, and is manufacturing some powerful experimental field-guns (Lavroff guns) of this alloy treated in the same way as described with regard to the Austrian "Uchatius" field-pieces.

In Austria great attention has always been paid to bronze and analogous alloys, and General Von Uchatius, the Director of the Gun-foundry at Vienna, has for years studied the subject. In a lecture lately delivered by him, he tells us that about three years ago his attention was particularly called to a fragment of bronze, cast under pressure, which the Archduke William had brought from Russia. He found the properties of this metal so far superior to those of bronze cast in the ordinary way that he was led to researches which resulted in his casting bronze in an iron mold, or chill-casting, and at the same time chilling the interior of the mass by means of a core of solid copper, or otherwise. This bronze, which is an ordinary alloy, containing 8 per cent of tin, can be forged cold, and possesses many of the properties of steel, and has, consequently, been termed "bronze-steel"; it possesses, however, apparently, the advantage over steel of being a safer material when employed alone. The following table exhibits the mechanical properties of United States bronze:

Nature.		Composition.	Density.	Tenacity per sq. inch.	Limit of elasticity per sq. inch.	Elongation.		Hardness.
						Ultimate.	Elastic.	
				Lbs.	Lbs.	Per ct.	Per ct.	
U. S. Navy guns	Breech square	90 parts copper	8.765	46,500				
	Gun-head	10 parts tin	8.444	27,400				
Do.				60,000				
U. S. Army field-guns	Gun-head samples		8.497	29,859				
	Small bars	90 parts copper	8.557	42,754				4.57
	Finished gun	10 parts tin	8 766					5.94
	Small bars		8.800	52,000				
Reed brass (South Boston Iron Company)		Copper, zinc	8.4142	55,800	9,000	24	100	6.27
West Point foundry bronze, for life-saving mortars		90 parts copper	8.7972	50,831	17,000	56	200	4.57
		10 parts tin			20,000	42	200	5.24
South Boston Iron Company bronze, condensed by mandreling		Uncondensed	8 3512	35,810				5.40
		Condensed	8.7065	51,571				18.00

The work done in stretching to the elastic limit, and the point of fracture, is less for ordinary bronze than for wrought-iron of maximum ductility, and for low steel. This defect, added to the costliness of bronze, to the various embarrassments experienced in the casting of large masses, its softness and consequently rapid wear and compression, and to its injury by heat, has not warranted its employment for large calibers and high charges. The mean ultimate cohesion of bronze, according to European authorities and the experiments of the United States Government, is about 33,000 pounds per square inch. Rifled bronze guns would be naturally more liable to rapid deterioration than smooth-bores, as the weights of projectile and charge are much greater in the former in comparison to the area acted upon, and consequently the local heating at the seat of the charge is much more intense, thus tending to separate the copper and tin more or less from each other, forming those tin-spots and porous patches which injure the strength of the material. The reduction of windage also, in the rifle-gun, would tend to increase this local heating, and it must be remembered that bronze becomes hot very easily, and tin melts very soon (442° F.); moreover, the grooves in a rifle-gun open out many tin-spots which would remain unexposed in a smooth-bore. See *Cannon-metals, Compressed Bronze,* and *Phosphor-bronze.*

BRONZE GUNS.—The circumstances of chief difficulty and importance in the manipulation of bronze affecting the production of cannon are: 1. The chemical constitution of the alloy as influencing the balance of hardness and tenacity. 2. Its chemical constitution and other conditions influencing the segregation of the cooling mass of the gun when cast into two or more alloys of different and often variable constitutions. 3. The effect of rapid and slow cooling and of the temperature at which the metal is fused and poured. 4. The effect due to repeated fusions and to foreign constituents in minute proportions entering the alloy. In bronze, sufficient hardness must be secured to resist longest the abrasions of projectiles and deflagration of powder; along with the greatest ultimate tenacity, there must be certain rigidity and ductility with ultimate cohesion; hardness and rigidity increase with the proportions of tin; ductility and tenacity with that of the copper, but not in direct ratio; specific gravity increases with copper. The fusibility is greater than copper, and less than tin; ultimate cohesion less than that of tough copper, but greater than that of tin; ductility greater than tin, but less than copper; hardness greater than either. In consequence of the difference in the fusibility of tin and copper, the perfection of the alloy depends much on the nature of the furnace and treatment of the melted metal. By these means alone the tenacity of bronze has been carried at the Washington navy-yard as high as 60,000 lbs.

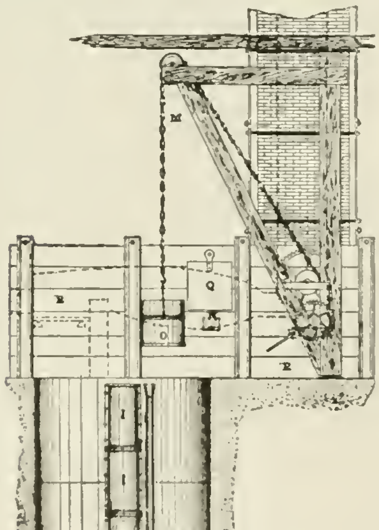
The first step in the fabrication of bronze guns at the foundry is to make an accurate working drawing of the gun, on a convenient scale, showing all lines clearly and with all its dimensions distinctly marked. The subsequent steps vary according to the method proposed to be used in casting. Formerly bronze guns were cast in loam or sand molds, but these have been superseded by a thick mold of cast-iron, called a *chill*. When cast in chills, bronze is denser, stronger, and more uniform than in sand; there is less liability of a separation of tin, or forming of a tin-copper alloy differing from bronze. A description of the process of casting in sand will supply details required for an understanding of the chill-casting. *When a casting is desired in sand*, a wooden pattern of the gun is made, following the shape of the drawing, but larger in all its dimensions, both by the shrinkage of the casting and also by the amount allowed for finishing, of never less than 1 inch over the finished diameter. The pattern is also made longer than required for the gun-casting, to form a sinking-head of a diameter about equal to that of the gun at the muzzle, and with a volume or weight, for ordinary guns, about one third that of the whole casting. This sinking-head supplies fluid metal to the casting as the latter cools, and receives any cinder or dross that would otherwise remain in and injure the casting. The sinking-head is cut off as soon as practicable after casting. The *pattern* is formed by planing the surfaces of moderately thick, clear plank, and gluing pieces of different widths together, the widest next the center of the pattern, until a sufficient thickness is obtained for each half the entire pattern, divided longitudinally. Two or more steadying-pins are then fixed in one half of the rough pattern, with corresponding holes in the other half, the surfaces having been fitted neatly to each other. The halves are clamped firmly together, carefully centered and turned in a lath to the proper dimensions. All projecting parts not annular must be attached to the pattern in separate pieces fitted to the turned surfaces of the partly finished pattern. Thus, separate pieces are turned for the trunnions, including the rimbases, the sight-masses, etc., and fastened to the pattern in their proper positions by pins in the wood, so that they may be readily removed. The whole pattern is carefully finished and smoothed with sand-paper, the angles and corners well rounded, and varnished to protect the wood from the moisture of the sand. The pattern and loose pieces are legibly marked.

The *flask* is longer than the entire pattern including the sinking-head, and contains sufficient sand around the pattern to permit proper ramming and to make the mold sufficiently secure, leaving room enough for the runner or gate at the side of the pattern. The flask is of hexagonal shape, divided longitudinally in two parts; each half has strong longitudinal flanges, and is strengthened crosswise by ribs running from flange to flange. Each side of the half flask which adjoins the flange is solid, but the third side, which lies uppermost in molding, is open save where the ribs cross it. This opening from one end to the other is for ramming, and is closed by movable plates, which are held down upon the sand by means of wedges driven under the ribs. For *molding*, half of the pattern is laid upon a flat surface—"follow-board"—which is somewhat larger than the flask. The latter is placed over the half pattern. Well-tempered sand mixed with clay and beer-lees is then rammed uniformly all around and over the pattern, so as to be of equal density and hardness throughout. The loose plates are then keyed down, the flask raised and turned over, and the surface of the sand closely sprinkled with fine, unadhesive parting-sand. The second half of the pattern is laid exactly on the first and kept in place by the steadying-pins; the other half of the flask put on, keyed to its fellow, filled with sand, and rammed evenly round as before and its plates keyed down. The two halves of the flask are then separated, the pattern removed, the main runner cut with a suitable tool along the sand on the surface where the flasks part, being made funnel-shaped at the top. Half the runner lies in each part of the flask, the main gate is cut from the bottom of the runner into the mold, and other gates above it. The main gate is cut tangent to the circumference of the mold, that the metal as it rises may receive a rotary motion. The mold is put into a drying-oven, raised to a high heat, 300 degrees or more, and thoroughly dried. The whole surface of the sand-mold is carefully coated with a wash of graphite, fire-clay, and molasses and water, and the mold dried again for a few hours. When it is ready for the casting the flask is placed in the pit upright on end.

When a chill is used, the process is as follows: The chill conforming to the curves of the pattern unites the functions of the flask and of the sand-mold, and by its high conducting power rapidly extracts the heat of the metal cast within it. The working draught of the gun being made as before, a drawing of the chill is made giving the dimensions required. From this the pattern is prepared, so much being added to every dimension, that when cold after casting the interior sizes of the chill may be those required by the casting of the gun. The chill is best divided longitudinally into halves on a plane at right angles to the trunnions, and also horizontally into two, or, if the gun is long, into more sections, the lower two of which, one on each side, contain the recesses forming the trunnions and rimbases. Four pieces are provided with flanges for clamping them together. An additional section, added for the cascabel, is made with a broad flange upon which the whole chill when keyed together securely stands. The gun-casting proper is thus inclosed in a cast-iron mold, and is quickly chilled. The sinking-head is molded in dry sand, that it may remain liquid to feed the casting as long as possible. The pattern for the sinking-head is a cylindrical piece of wood, of proper diameter and length, which is placed within a long cylindrical flask, open at both ends, and withdrawn after the sand has been rammed around it. This flask, or "pot," is made, fitted, and fastened to the top of the chill. Two patterns are requisite for the chill proper, and one for the base. They are made from the proper drawing like those for ordinary sand-castings, the internal dimensions being fixed as in the method previously described, by the shrinkage of the alloy and the amount left for finishing. The walls of the chill may be from 2½ to 3¼ inches thick. After the castings are made they are carefully smoothed or bored out when practicable; and all corners, especially in the trunnion-molds, likely to retain gas or to catch dross in casting are carefully smoothed over and rounded.

When a casting is to be made, the parts of the chill are cleaned, fastened together, covered inside with a wash of fire-clay, molasses and water, and heated to a moderately high heat in an oven. At casting, the chill is brought out and the sinking-head mold keyed to it. The metal may be poured direct into the mold or through a separate runner at the side opening into the chill at the bottom. If poured direct, the stream falls from the top straight downward from a small box lined with sand, which receives the metal from the ladle. If a side runner is used, it is divided longitudinally; the halves are fastened together by flanges and bolts. The base of the chill is fitted to receive the runner, which is, at the bottom, contained in a cast-iron box bolted to the chill and leading horizontally into the opening. Each half of the pipe receives the sand for the runner, which is also molded as above and dried in an oven. The side runner has the advantage of keeping the metal cleaner in the casting through the rotary motion imparted by the stream flowing into the mold tangentially, but it is apt to leave the sinking-head too cool, and hence the latter is, in any case, best poured direct after the mold or chill has been filled above the top of the gun.

For casting it is most convenient to place the chills or flasks in a pit, P, in such a position as to be easily reached by the crane-ladle, O, used for pouring. The



pit may contain several chills at once, and the crane, M, commands both the furnace and the pit. As soon as the bronze is melted the ladle is brought beneath the tapping-hole, N, the metal tapped into it, and the ladle swung around over the chills. *The furnace* is reverberatory, fired with soft bituminous coal, and is so constructed that the metal as it melts runs into a pool at the end furthest from the fire, thus removing it from the immediate action of the flame. The bottom of the furnace is made of fire-clay rammed hard. A door of convenient size is placed in the side of the furnace for charging, taking samples of molten metal for test, etc., and the tapping-hole is usually placed under it for convenience of access. The furnace is charged by laying the metal selected, which may be either old guns or sinking-heads, or new copper, or chips from the lathe, on boards on the bottom of the furnace, distributing it carefully so as to expose all pieces properly to the flame, that they may come into fusion at about the same time. The copper is charged as bought in pigs, but guns and heads are cut up into pieces of convenient size. The tin is charged in the shape of small ingots recast for the purpose, about 12 inches long by ½ inch square.

The composition of the charge is varied to suit the metal used, but the total weight must be sufficient to cast the gun and sinking-head and leave some surplus. For the 3½-inch rifle cast in 1876 the charge was as follows:

	Pounds.
Old guns cut up....................	2650
New copper in ingots................	830
Tin, in small bars.............	104
Total	3584

The whole casting weighed 3126 pounds, for a finished weight in the gun of 1322 pounds. The riser when cut off weighed 700 pounds, and there was a waste in the furnace of 1.6 per cent. After the old bronze or copper has been charged, the furnace is closed and fired up gently at first and more strongly as the metal sinks down away from the flame, which must always be kept smoky, i.e., of a reducing character. When the bronze or copper is melted the tin is added; it is thrown into the bath at different points and worked under the surface as much as possible, as it floats buoyantly till alloyed. The bath may be stirred thoroughly with an iron bar, or, if much old metal be used, with a pole of green wood. After the metal is wholly melted it is kept in fusion for some time—about half an hour—in order that a thorough alloy may be effected, and a proper temperature be reached for casting. The alloy is examined for its cold fracture by means of specimens taken out of the furnace in a small ladle. When the fracture is brought to the proper yellow-red color, judged by experience, and the heat has reached the proper point, the bronze is ready for casting. For the gun above quoted, the furnace was lighted at 8 A.M., the metal melted at 10.25 A.M., and the casting was made at 11.30 A.M., or in 3 hours and 30 minutes in all.

The tendency of bronze to separate into alloys of different composition is so strong that specimens taken at different heights in the mold exhibit very different densities and strengths. A series of specimens cast in the same sand-mold with the gun and contiguous to it, but separate from the gun-casting proper, showed a constant decrease of strength from the cascabel to the sinking-head, as follows:

AVERAGE.	Bottom of sinking-head.	Side specimen A.	Side specimen B.	Side specimen C.	Finished gun as a whole.
Density	8.440	* 8.597	8.660	8.686	8.649
Tenacity........	26,760	39,364	41,974	43,062	....

The average density of one hundred and twenty-four 24-pounder bronze howitzers, made for the Navy Department in 1863 and 1864, between the South Boston foundry-numbers 1417 and 1693, was 8.722, and average tenacity 50,041 pounds per square inch. The averages of forty-five guns, from No. 434 to 478, inclusive, were density 8.653, and tenacity 33,665 pounds per square inch. On the other hand, nine guns included in the first series, and made between foundry-numbers 1556 and 1615, exhibited an average density of 8.804, and an average tenacity of 60,610 pounds to the square inch. See *Dean Field-gun, Ordnance,* and *Uchatius Gun.*

BRONZE-STEEL.—This name is given to the metal obtained by the process of General Von Uchatius of the Austrian service, and Lavroff in the Russian service. The metal is obtained by casting bronze in a chill-mold and forging it cold. The guns are made by casting on a core in a chill mold. The gun is then inclosed in a steel casing, and the bore expanded by forcing in steel mandrels slightly tapered, and gradually increasing in size, by which the diameter of the bore is increased 5 or 6 per cent, and the hardness increased. This has the effect of putting the interior metal in a state of compression, and the exterior in a state of tension, while the metal has almost the strength, hardness, and elasticity of steel. See *Bronze* and *Steel.*

BRONZING.—The process of covering articles so as to communicate to them the appearance of ordinary bronze. Gun-barrels are bronzed by acting upon them with the chloride or butter of antimony (*bronzing* salt), or with hydrochloric or nitric acids, when the surface of the iron gets partially eaten into and covered with a thin film of oxide; after which the gun-barrel is thoroughly cleaned, oiled, and burnished. A brownish shade is thus communicated to the barrel, which protects it from rust and at the same time renders it less conspicuous to an enemy. In the bronzing operation known as the Damascus, the barrel is treated with dilute nitric acid and vinegar, to which sulphate of copper has been added. The result is that metallic copper is deposited irregularly over the iron surface; and when the latter is washed, oiled, and well rubbed with a hard brush, a very pretty appearance is communicated to the barrel. See *Browning.*

BROOKE HOOPED GUN.—A cast-iron gun, hooped with wrought-iron rings. Although slightly hooped, the fine quality of material insures considerable endurance. One gun is stated to have fired double charges without injury. The 7-inch gun (all other calibers are similar in design) is used with 14 pounds of powder and an 80-pound shell. The following are its particulars:

Total length	146.05	inches.
Length of bore	119.90	"
Length of wrought-iron reinforce	30.00	"
Length muzzle to center of trunnions	80.50	"
Length center of trunnions to forward end of reinforce	10.90	"
Diameter of bore	7.00	"
Diameter of muzzle	14.55	"
Diameter of cylindrical part of casting under reinforce	27.20	"
Diameter over reinforce	31.20	"

The rifling consists of seven grooves $\frac{1}{10}$ inch deep, very slightly rounded at the corners, with one turn in forty feet. The grooves vanish as they approach the chamber. The gun resembles Parrott's in shape and construction, except that the reinforcing band is made up of rings not welded together. See *Ordnance.*

BROTH.—An infusion or decoction of vegetable and animal substances in water. It is customary in the army to use more or less meat, generally ox-flesh, with bone, and certain vegetables, as cabbage, greens, turnips, carrots, peas, beans, onions, etc. The whole are mixed together in cold water, heat slowly applied, and the materials allowed to simmer for some hours. The meat yields up certain ingredients, whilst others are retained in the residual flesh. The following will illustrate this: Ox-flesh heated with water yields to the water albuminous matter, gelatine, kreatine, extractive matters or osmazome, lactic acid, salts, fat, and saccharine matter; and leaves in the boiled meat fibrin, coagulated albumen, gelatinous tissue, fat, and nervous matter. The vegetables yield albuminous constituents, coloring and mucilaginous matter, and volatile oils and salts. The real nutritive material present in broth is less than is generally thought, though it aids in satisfying the cravings of the appetite. In the hospital, however, the form of broth known as beef-tea is of great importance, as it affords the weak and sickly stomach a light palatable article of diet at a time when stronger food would do the weakened system much harm.

BROUGHTON GUNS.—A variety of very excellent arms bearing this name have been invented and tested, —three of which compare very favorably with the well-known arms of their respective systems.

No. 1 is a breech-loading rifle having a fixed chamber closed by a movable breech-block rotating about a vertical axis at 90 degrees to the axis of the barrel, and not in the plane of the axis of the barrel (all to the right and in front). This piece is opened by drawing back the firing-bolt to cock the piece, and pressing down on the thumb-piece to liberate a spring-catch in the breech-block from its notch in the receiver, and to allow the block to swing outward and forward until nearly parallel to the barrel. The guard is connected with the receiver by an undercut groove in front and a spring-catch in rear, and when detached from the gun carries with it the lock complete.

No. 2 is a breech-loading rifle having a fixed chamber closed by a movable breech-block which rotates about a horizontal axis at 90 degrees to the axis of the barrel, lying above the axis of the barrel and in front. This piece is opened by cocking the piece so as to withdraw the nose of the hammer from the counter-bore of the firing-pin hole, and then pressing forward the latch-lever, which passes through the firing-pin, until the head of the pin is disengaged from the corresponding cavity in the receiver, and the breech-block is free to swing upward and forward over the barrel. The action does not differ materially from that of the Springfield.

No. 3 is a breech-loading rifle having a fixed chamber closed by a movable breech-block which rotates about a horizontal axis at 90 degrees to the axis of the barrel, lying below the axis of the barrel and in front, being moved from below by a lever. By the first motion of depressing the lever, which is pivoted on the breech-block near its rearmost corner, its upper end presses back the locking-brace from under the lock. It thus allows the block to swing downward and backward, as soon as by the continued motion of the lever it strikes the under surface of the block so as to cause its revolution about the block-pin, and to expose the chamber for the insertion of the charge. As the locking-brace is pushed back it also brings the hammer to the half-cock.

BROW-BAND.—A band of a bridle, head-stall, or halter, which passes in front of the horse's forehead, and has loops at its ends, through which pass the cheek-straps.

BROWN BESS.—A very ancient and quite renowned smooth-bore fire-arm. This musket helped to win the battles of Marlborough and old Fritz, of Wellington and Napoleon, and figures largely in military history.

BROWN BILL.—The ancient weapon of the English foot-soldiers, resembling a battle-axe.

BROWN COAL.—A mineral substance of vegetable origin, like common coal, but differing from it in its more distinctly fibrous or woody formation, which is sometimes so perfect that the original structure of the wood can be discerned by the microscope, while its external form is also not unfrequently preserved. In this state it is often called *wood-coal;* and it sometimes occurs so little mineralized that it may be used for the purposes of wood, as at Vitry, on the banks of the Seine, where the wood-work of a house has been made of it. From this to the most perfectly mineralized state it occurs in all different stages. It is often brown or brownish black, more rarely gray. It burns without swelling or running, with a weaker flame than coal; emits in burning a smell like that of peat, and leaves an ash more resembling that of wood than of coal. Wherever it occurs in sufficient abundance it is used for fuel, although very inferior to common coal. *Bovey coal,* so called from Bovey Tracey, in Devonshire, where extensive beds of it occur, and where it has long been wrought, is brown coal, and often exhibits the woody structure very beautifully. See *Coal.*

BROWNING.—Browning is the coating given to a gun to protect it from the action of the atmosphere, and to prevent the surface from reflecting the sunlight. The process of browning small-arms consists in forming a coat of rust, with a mixture of such materials as *spirits of wine, blue vitriol, tincture of steel, nitric acid*, etc., on the clean surface of the barrel, and then rubbing it well with a *steel scratch-card* until it has a metallic luster. This operation is repeated about a dozen times, until the coating has a deep brown color. The barrel is then washed with boiling water, to dissolve away any of the corroding mixture that may remain, and, when cold, is covered with sperm-oil. When the browning has been worn away in places, it may be entirely removed—first by boiling in lime-water, to remove the varnish or grease, and then soaking in vinegar, which loosens the browning so that it can be wiped away with a rag.

The following method, embodying seven operations,

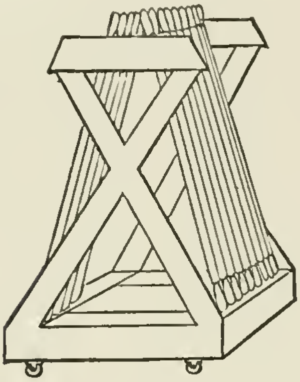


Fig. 1.

is used for browning small-arms at the National Armory:

First Operation.—The first operation with the barrel is to oil the bore with pure sperm, and plug each end to prevent the entrance of either *lime-water*, boiling water, or the browning mixture.

Second Operation.—Place a number of the barrels in a tank of boiling *lime*-water, and allow them to remain thirty minutes, until all grease is removed. After this brush off the lime with a *clean* brush, and avoid touching the barrels with the hand.

Third Operation.—Apply evenly with a clean fine

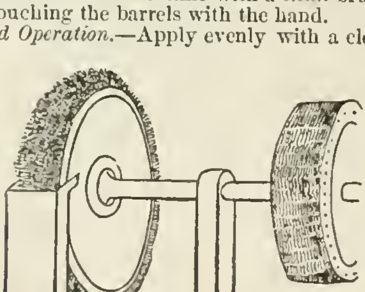


Fig. 2.

sponge a coating of the browning mixture; the barrels are then placed on a rolling or movable frame (Fig. 1). The frame is then rolled into the steam-case, having received its complement of barrels.

Fourth Operation.—Rusting the barrels is accomplished in six or seven hours in the steam-case, at a temperature of 85° and humidity of 70 per cent, determined by the thermometer and psychrometer. By reducing the supply of steam the barrels can remain for a greater length of time (overnight).

Fifth Operation.—Remove the barrels from the steam-case and place them in the hot-water tank (water heated by coils of steam-pipe), where they remain for *fifteen* minutes, when all trace of acid disappears.

Sixth Operation.—An expert operative then passes the barrel obliquely across the surface of a revolving *brush-wheel*, thereby removing all loose particles of oxide (Fig. 2). This wheel is about twelve inches in diameter and four or five inches thick, set on periphery with Russia bristles, and has about eight or nine hundred revolutions per minute.

Seventh Operation.—The operative, after brushing the barrel (which is accomplished in a few moments), in like manner holds it obliquely across the face or surface of the card-wheel (the teeth of which are bent backward) until the surface of the barrel is carded or burnished evenly. The card-wheel (Fig. 2),

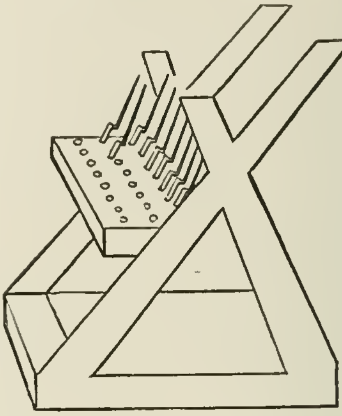


Fig. 3.

revolving at the same rate as the brush-wheel, accomplishes its work in a few moments. After the seventh operation the barrels are ready to receive the *second* coat of browning, when the seven operations before enumerated are repeated. In like manner the *third* and *fourth* applications of the mixture are followed by the several steps before noted.

The browning of bayonets, bayonet-scabbards, bayonet-clasps, and ramrods is accomplished in the same general manner as for barrels (Fig. 3). For convenience a steel spring handle is used to hold the rammer. After the various parts are browned they are well coated with cosmoline or olive-oil.

To Brown a Gun.—Scrape clean; scrub with fresh water, sand, and canvas; allow to dry; wipe off; apply a strong solution of salt and vinegar three or four times a day for two days, or until a good coat of rust is formed; allow to dry, then rub lightly with old canvas; apply a thin coat of the following mixture, rubbing it in well: 4 lbs. beeswax, melted and strained; .50 oz. pure vitrol (white), or 1 oz. pulverized alum; 1 gallon spirits of turpentine. Allow to dry until next day; then put on another thin coat, and when dry rub with a clean cotton cloth. In case of a dull appearance, by reason of having been handled, rub over with a cotton cloth and spirits of turpentine, and then with a dry cloth. See *Bronzing*.

BROWN PIGMENTS.—Substances in which the three primary colors unite in unequal proportions, red being in excess. Brown pigments are chiefly mineral, and are used in the laboratory, sometimes in a raw but usually in a burned state. The most important are bister, asphaltum, umber, terra di sienna, Mars brown, Cassel earth, and brown madder.

BROWN SIGHT.—A valuable improvement in the rear-sight on the U. S. service rifle has been recently proposed by Lieutenant W. C. Brown, U. S. Army. The rear edge of the buckhorn plate is beveled nearly or quite to a sharp edge, and the graduation for wind-allowance being brought down to this edge, the points and fractions thereof are easily read against the outer edge of the leaf. To further facilitate the reading of fractions of a point, a straight line has been drawn on each branch of the leaf, and at such a distance therefrom as to coincide with the outer division when the wind-gauge is at zero. See *Pointing* and *Sight*.

BRUCE STOP.—A stop intended to sustain the Springfield breech-block in the position of loading, when the muzzle of the gun is elevated, or the piece is much shaken, as on horseback at a trot. It consists of a spring and spindle like those used for the ejector, and lying in a counterbore on the opposite side of the receiver. When the block is open, the point of the spindle lies within a shallow cavity in the front surface of the hinge on the breech-block, and is pressed against it by the spring with sufficient force to hold it up, and yet to permit the pressure of the hand properly applied to easily close the piece.

BRUGERE POWDER.—An explosive compound of ammonium picrate and niter. It has been experimented with for use in shell in England, as it acts when strongly confined more violently than gunpowder. See *Explosive Agents* and *Picrates*.

BRUNEL TARGET.—A canvas target used by the Dominion of Canada Rifle Association at Ottawa. The framework of the target is made of iron, about one inch thick, and sharpened like a V in front. The target moves up and down along two iron guide-rods, having a counterbalancing weight attached. When the target is hit, the marker (sheltered by a parapet and trench) draws it down the guide-rods, until it stands before him. He then hangs in the bullet-hole a cardboard disk (provided with a wire hook), painted to indicate its value, lifts the handles, and raises the target to view again. The marker repeats this operation at each hit, taking the disk out of the former hole, patching that hole up, and hanging the disk in the new hole. These disks may be shot through and through several times, and when worn out may be cheaply replaced. See *Target*.

BRUNIA.—A coat of mail worn by the early Franks. It was a short and tight species of *paletot*, more or less closely covered with small pieces of metal sewn upon the fabric of which the piece of armor was composed.

BRUNSWICK BLACK.—A varnish employed for coating over coarsely finished iron-work. It is mainly compounded of lamp-black and turpentine, and when applied with a brush quickly dries, and leaves a shining jet-black surface.

BRUNSWICK GREEN.—A pigment used in the laboratory, and consisting of the hydrated chloride and oxide of copper ($CuCl,3CuO,4HO$). It may be prepared (1) by acting upon metallic copper with common salt and diluted sulphuric acid; (2) by acting upon metallic copper with moistened sal-ammoniac; or (3) by mixing sulphate of copper and common salt into a paste with water. It is found native at Atacama, in Peru, in the form of a green sand, hence the name Atacamite.

BRUNSWICK RIFLE.—This rifle, with back-action hook-lock, was introduced into the English army in the reign of William IV. Its weight with sword-bayonet and scabbard was 11 pounds 5½ ounces; weight of barrel, 3 pounds 14 ounces; length of barrel, 2½ feet; number of grooves, 2, making one turn in the length of the barrel; weight of bullet (which was spherical and belted), 557 grains; diameter, .696 inch; charge of powder, 2⅛ drams. This rifle, from the ball having a belt round it with a patch to prevent its "stripping," was found an inconvenient weapon, in consequence of the delay experienced in placing the belted ball properly in the grooves, without which loading was impossible. The rifle soon fouled, and its shooting beyond 400 yards was wild.

BRUNT.—The troops who sustain the principal shock of the enemy in action are said to bear the *brunt* of the battle.

BRUSHWOOD.—Rough, low, close thickets; under wood, branches of trees cut off. The use it is put to is in making gabions, fascines, and pickets. Brushwood for the above purposes should not exceed 1¼ to 2 inches in diameter at the butt or thick end. Brushwood is cut and tied up in bundles, weighing from 40 to 50 lbs. each.

BUCCANEERS.—A celebrated association of piratical adventurers, who, from the commencement of the second quarter of the sixteenth century to the end of the seventeenth, maintained themselves in the Caribbean Seas, at first by systematic reprisals on the Spaniards, latterly by less justifiable and indiscriminate piracy. The name is derived from the Caribbee *boucan*, a term for preserved meat, smoke-dried in a peculiar manner. From this the French adventurers formed the verb *boucaner* and the noun *boucanier*, which was adopted by the English; while, singularly enough, the French used, in preference, the word *flibustier*, a corruption of our "freebooter." The Buccaneers were also sometimes called "Brethren of the Coast." The arrogant assumption by the Spaniards of a divine right—sanctioned by the Pope's Bull—to the whole New World was not, of course, to be tolerated by the enterprising mariners of England and France; and the enormous cruelties practiced by them upon all foreign interlopers, of which the history of that time is full, naturally led to an association for mutual defense among the adventurers of all other nations, but particularly among the English and French. The fundamental principles of their policy—for they, in course of time, formed distinct communities—were close mutual alliance, and mortal war with all that was Spanish. Their simple code of laws bound them to a common participation in the necessaries of life; locks and bars were proscribed as an insult to the general honor; and every man had his comrade, who stood by him when alive, and succeeded to his property after his death. The principal center of their wild and predatory life was for some time the Island of Tortuga, near St. Domingo. When they were not hunting Spaniards, or being hunted themselves, their chief occupation and means of subsistence was the chase. From the flesh of wild cattle they made their "boucan"; their skins and tallow they sold or bartered to Dutch and other traders. The history of these men embraces, as may be supposed, narratives of cruelty and bloodshed unsurpassed in the annals of crime. It has, however, not a few stories of high and romantic adventure, of chivalrous valor, and brilliant generalship. Among the "Great Captains" whose names figure most prominently in the records of buccaneering, were the Frenchman Montbars, surnamed by the terrible title of "The Exterminator"; and his countrymen, Peter of Dieppe, surnamed "The Great"—as truly, perhaps, as others so distinguished—and L'Olonnas, Michael de Busco, and Bartolomeo de Portuguez, Mansvelt, and Van Horn. Preeminent, however, among them all was the Welshman, Henry Morgan, who organized fleets and armies, took strong fortresses and rich cities, and displayed throughout the bold genius of a born Commander. He it was that led the way for the Buccaneers to the Southern Ocean, by his daring march in 1670 across the Isthmus of Panama to the city of that name, which he took and plundered after a desperate battle. This brilliant but most unscrupulous personage was knighted by Charles II., and became Deputy Governor of Jamaica. A higher subordination of the love of gold to the passion for dominion in him might probably have made him Emperor of the West Indies, some dream of which seems at one time to have occupied his mind. In 1680 and 1689 extensive buccaneering expeditions were made to the Pacific, even as far as the coasts of China, of which the best record is preserved in the lively pages of William Dampier, himself an important partner in these bold adventures. The war between France and Britain, after the accession of William III., dissolved the ancient alliance of the French and English Buccaneers. After the peace of Ryswick, and the accession of the Bourbon Philip V. to the Spanish crown (1701), they finally disappeared, to make way for a race of mere cut-throats and vulgar desperadoes, not yet utterly extinct. The last great event in their history was the capture of Carthagena in 1697, where the booty was enormous.

BUCCELLARII.—An order of soldiery under the Greek Emperors, appointed to guard and distribute the ammunition-bread, though authors are somewhat divided as to their office and quality.

BUCEPHALUS.—The favorite charger of Alexander the Great; probably also the name of a peculiar breed of horses in Thessaly. According to tradition, Alexander in his boyhood was the first to break in the steed Bucephalus, and thus fulfilled the condition stated by an oracle as necessary for gaining the crown of Macedon. The town Bucephalia, on the river Hydaspes, in India, was founded near the grave of Bucephalus, which died during Alexander's Indian Expedition.

BUCK-AND-BALL CARTRIDGE.—A small-arm cartridge containing a round musket-ball and three buckshot, formerly much used in smooth-bore muskets.

BUCKLE.—A metal instrument, consisting of a rim and tongue, used for fastening straps or bands in equipments and harness. In the latter half of the last century the manufacture of buckles was carried on most extensively in Birmingham, there being at one time not less than 4000 people employed in that town and its vicinity, who turned out 2,500,000 pairs of buckles annually, at the average value of 2*s.* 6*d.* per pair.

BUCKLE PROJECTILE.—In this projectile, a cup of lead at the base of the shot is held in place by a thin brass sleeve which is forced into the grooves of the gun.

BUCKLER.—In old armor, a kind of shield worn on the left arm. The bucklers worn by the *hastati*, or spearmen, among the ancient Romans, were about 4 feet long by 2½ in width, made of boards, covered on the inside with linen and sheepskin, and on the outside with iron plate. In the Middle Ages the buckler was round, oval, or square in shape, and was frequently made of wicker-work or of hide, strengthened by metal plates.

BUCKSHOT.—A kind of leaden shot, larger than swan-shot, now used in hunting game, but formerly used in military service. Those employed for making musket-cartridges weighed about 160 or 170 to the pound: 15 (sometimes 12), or a caliber .69 ball and 3 buckshot, were put in a cartridge. Buckshot are usually made by molding or compression.

BUCKSHOT-CARTRIDGE.—A cartridge usually containing 12 buckshot, arranged in four layers. The layers are kept in proper position by passing one half-hitch of the choking-thread between every two layers; the thread is firmly secured by passing two half-hitches around the upper layer. For rifle-arms, the shot-end of the cartridge should be dipped in the composition commonly used for lubricating bullets; with this precaution all leading of the grooves will be avoided. In the United States buckshot-cartridges are principally used in Indian warfare, and especially in night-firing. Until very recently, they were much used in military service, and were adapted to a variety of arms.

In England this cartridge is used with the Snider arms of .577 bore. The cartridge for the muzzle-loader consists of two paper cylinders, one containing 2½ drams of R. F. G. powder, the other containing 12 buckshot, weighing about 220 to the pound. Buckshot-cartridges for the breech-loaders are similar, and are issued to convict-warders. See *Multiball Cartridge* and *Wright Multiball Cartridge*.

BUCKSKIN.—A fanciful name for a heavy-made, strong-twilled woolen fabric for military trouserings, highly milled to about the usual width for such goods—27 inches; and cropped and finished, with the pile or nap so shorn as to show the texture through it.

BUDGE-BARREL.—A small copper-bound barrel having only one head, its mouth being closed by a leathern bag with a cap and draw-string. It is used for supplying the guns of forts and siege-batteries with cartridges from the magazine.

BUFF.—The leather of which belts and certain equipments are usually made. The following is the process pursued in its preparation:

Buff or "losh" leather is manufactured chiefly from the hide of the buffalo. The process of softening, removing the hair, cleansing, etc., is precisely the same as that for common leather (*vide* Leather), until the "pelt" is ready for tanning, when it has to be prepared for a process of oiling. This is done by carefully removing or forcing off the upper grain of the hide, which renders both sides of it as nearly alike as possible. The hides are then subjected to the process of "branning," that is, being steeped in fermented bran from four to twelve hours, according to the atmosphere. They are then wrung out or scraped over, and subjected to the pulling-mill or stocks for two or three hours; afterwards they are spread out and oiled. Cod-oil is the best for this purpose. The oiling is repeated during the first three or four days until each hide has absorbed ¾ of a gallon. For the following three weeks the hides are subjected to alternate soaking and drying, in which great care and attention are required. They are then exposed to a heating process, in hot-houses prepared expressly for the purpose, for two or three days, the heat not exceeding 130° Fahrenheit. Having arrived at this stage, the oil has now to be extracted, which is effected by a solution of potassa, in mills constructed for this purpose. The buff is next carefully cleaned from all alkaline matter by frequent washings, and each hide hung up separately to dry. The facing or surface is completed by rubbing both sides with pumice-stone, and the buff is then in a fit state to be cut up into accouterments.

BUFFALO.—An animal of the ox tribe, very useful as a pack-animal. It is a native of the East Indies, where it has long been domesticated, and whence it was carried to Egypt and the south of Europe. It was introduced into Italy about the close of the sixth century, and is now very generally used as a beast of burden in that country, as it is also in India. It is used in India to a very great extent by the military in field operations. See *Pack-animals*.

BUFF COAT.—A close military outer garment, with short sleeves, and laced tightly over the chest, made of buffalo-skin, or other thick and elastic material, worn by soldiers in the seventeenth century as a defensive covering.

BUFFER.—A contrivance, as applied in the service of artillery, for checking the recoil of heavy guns. The hydraulic buffer consists of a wrought-iron cylinder, closed at one end, the other end fitted with a cap and stuffing-box, through which a piston-rod-passes. The piston fits well into the cylinder, and is perforated with four small holes, the size of which varies with the size of the gun. The cylinder is filled with Rangoon oil or with water, enough air-space being left to act as an elastic buffer, which takes off the violence of the first impact of the piston on the oil. The cylinder is firmly attached to the platform on which the carriage recoils, and the end of the piston-rod to the carriage itself; so that on the discharge of the gun, the carriage drives the piston through the oil or water with great velocity, gradually bringing the gun and carriage to rest in the required distance. See *Hurter* and *Pneumatic Buffer*.

BUFFING AND POLISHING MACHINE.—One having a wheel covered with buff-leather, though not usually made out of cow-hide. The leather holds the polishing material, crocus, rouge, or what not. Buffing has come to mean polishing, from the derived name of the material which is used in applying the polishing material.

BUFFINGTON MAGAZINE-GUN.—This gun belongs to that system in which a fixed chamber is closed by a movable breech-block, sliding and rotating, and operated by a lever from below. The receiver, to which the barrel is attached in the usual way, has a vertical slot entirely through it for the reception of the breech-block, and two grooves, at right angles to each other, on the inner surface of each side. In these grooves the flattened ends of pivots passing through the breech-block slide. The various points of the breech-block, not in the axes of the pivots, thus describe arcs of ellipses when the block is opened or closed. The block is hollowed out to receive the hammer, mainspring, etc. The hammer is slotted to receive one branch of the mainspring which abuts against a pin. The other branch bears against a similar pin through the breech-block. The piece is locked by lugs projecting from pieces screwed to the sides of the receiver, partly across its top and entering grooves on the hammer. The firing-pin is retracted, when the block is unlocked or the hammer cocked, by a slot which receives the head of the pin. The extractor is a bent spring hook secured at its rear to the breech-block by a pin and supported at its front by a pivot. In order to open the block, it is necessary to draw back the hammer to a point a little beyond the full cock, and then control the motion by a lever. Should the hammer be let down while the block is open, it is cocked in the act of closing by the edges of a surface striking on projections on the inner rear surface of the receiver. The magazine is in the tip-stock. It is provided with two cartridge stop-springs. The carrier is made of sheet steel brought to a spring temper, and is secured to the breech-block by a pivot. When the breech-block is closed the carrier-block descends, its spring keeping it in contact with the breech-block, bears down on a stop spring, and slides under the end of the magazine-tube. As it passes under the tube inclined planes raise the ends of a cross-piece riveted to the stop-spring, when a cartridge is forced by the magazine-spring into the carrier. A cut-off enables the piece to be used as a single-loader. As a magazine-gun, three motions are necessary to operate, viz., opened, closed, fired. As a single-loader, four motions are necessary, viz., opened, loaded, closed, fired. This gun carries six cartridges in the magazine and one in the chamber. See *Magazine-gun.*

BUFF JERKIN.—Originally a leathern waistcoat; afterwards one of a buff color, worn as an article of dress by Sergeants and Catchpoles; used also as a dress.

BUFFLETIN.—A stout covering for the body, having a very high stock. It took the place of the cuirass in Germany and in France during the Thirty Years' War.

BUFF-STICK.—A wooden stick covered with buff-leather, used by soldiers in cleaning their equipments.

BUGLE—BUGLE-HORN.—A very old Saxon horn, now used by many infantry regiments. By its soundings their maneuvers are directed, either in advancing, skirmishing, or retreating. The calls to quarters and academic duties, at the United States Military Academy, have for many years been sounded on the bugle.

BUGLER.—One who plays the bugle. In the United States service the buglers are enlisted men, in the Drum Corps or attached to Companies.

BUILT-UP GUNS.—No modern theory of constructing guns can be called new, since guns are in existence that have been either recovered from wrecks, or preserved in other ways, showing every variety of coils, hoops, casting, wire-binding, and so on, as far as the appliances then in use could furnish the quondam inventors with means of carrying their inventions into effect. That in which novelty has been attained is the improvement of processes by which large castings or forgings, accurate turning and boring, can be secured, or by which chemical knowledge can be brought to bear on the manipulation of metals; but no such progress can make a built-up gun, or machine of any sort, stronger than a perfectly homogeneous one, in which the varying strains are closely calculated and properly met by the scientific disposition of the necessary strength. The terms "built-up" and "hooped" are applied to those cannon in which the principal parts are formed separately and then united in a peculiar manner. They are not necessarily composed of more than one kind of metal; some of the most important are made of steel alone; and they may be made by welding or by screwing the parts together, and by shrinking or forcing one part over another. The object of this method of manufacture is to correct the defects of one material by uniting with it opposite qualities of the same or other materials. The defects which follow the working of large masses of iron or steel, such as crystalline structure, false welds, cracks, etc., are avoided by first forming the parts in small masses of good quality and then uniting them separately.

In considering the effect upon a yielding material of any force which may be applied, the rate of application of the force, or the time which elapses from the instant when the force begins to act until it attains its maximum, should not be neglected; for, with equal ultimate pressures per square inch of surface, that force will be most severe upon the gun which attains this pressure in the shortest period of time. The most obvious method of enabling a gun to sustain a greater elastic pressure is simply to thicken its sides, thus increasing the area of the parts to be torn asunder. This rule has been found to work practically with guns of small caliber; but in larger guns it does not work, from the fact that, in cast guns, of whatever metal, the outside helps but very little in restraining the explosive force of the powder, the strain not being communicated to it by the intervening metal. The consequence is that, in large guns, the inside is split while the outside is scarcely strained. This split rapidly increases, and the gun ultimately bursts.

If we take any transverse section of a gun, any unit in length, and suppose the metal to be divided into any number of concentric rings, it will be evident that the greater the distance of any ring from the axis of the gun, the less will it be stretched by the expansion of the bore when the piece is discharged, and consequently the less will it contribute to the general strength of the gun. If the strain upon the bore from the discharge be considered merely as a pressure—statical force—the resistance offered to it by any two rings will be inversely proportional to the square of their circumferences or distances from the axis of the gun. It will, therefore, appear that there is a certain limit beyond which it would be useless to increase the thickness of the metal; viz., when the force exerted on the surface of the bore would be sufficient to rupture the interior portions of the metal before the strain acted to any extent upon the exterior parts. Any arrangement of the parts by which the explosive strain is distributed equally over the entire thickness of the piece necessarily brings a greater amount of resistance into play. In order to obtain the requisite resistance, and with a moderate thickness of metal, it is desirable to equalize, as far as possible, the strain upon every portion of the metal.

There are two general methods of accomplishing this, viz.: first, by giving the exterior portions a certain *initial tension*, gradually decreasing and passing into compression towards the interior, which is done by shrinking heated iron bands or tubes around the parts to be compressed, or by slipping a tube into the bore, which has been slightly enlarged by heat; secondly, by means of the system of *varying elasticity:* this is accomplished by placing that metal which stretches most within its elastic limit around the surface of the bore, so that by its enlargement the explosive strain is transmitted to the other parts. These two methods of equalizing strains without an inordinate increase of thickness are so important that they deserve more than a passing notice. They are called the systems of Initial Tension and Varying Elasticity. Some gun makers use the one, some the other, some a combination of the two, and even in our own hollow-cast guns the idea of initial tension is one of primary importance.

It will be observed that built-up gun-constructions are alone considered as affording a reasonable solution of the problem; that steel tubes in combination with wrought-iron or steel constitute the prominent types; that breech-loading systems, using the interrupted screw or French pattern, are rapidly superseding muzzle-loading guns; and, finally, the more advanced opinions lead strongly to the belief that the true direction in which progress is to be made and light guns secured, combining great strength with high power, resulting from the use of large charges of powder and heavy projectiles, and in bores ranging from 26 to 30 calibers in length, is to introduce a greater degree of subdivision than found in the present systems by the use of steel wires superimposed on steel tubes, which in their turn are jacketed and finished externally by steel bands. See *Armstrong Guns, Blakely Gun, Cannon, Fraser Gun, Initial Tension, Ordnance, Palliser Gun, Parsons Gun, Varying Elasticity*, and *Woolwich Gun*.

BUKORS.—Kettle-drums of the Swedish cavalry. They do not differ materially from the usual kinds.

BULLARD RIFLE.—A repeating rifle recently introduced by a Mr. Bullard, who was for five years master-mechanic at the well-known Smith & Wesson Works. The action of this rifle is positive and not dependent upon springs. It is self-cocking, with a solid breech-block behind the bolt, which must be in place and securely locked before it is possible for the hammer to reach the firing-pin. It is possible to fire this rifle with very great rapidity, from the fact that it works easily and smoothly by reason of its direct leverage on the work to be done, the heaviest work being done with the best leverage, as in extracting the cartridge, which is started when the lever is in position to exert the greatest strain. Cocking the hammer is also done by direct leverage inside the receiver or frame instead of a sliding motion of bolt or firing-pin on and over the top of the hammer, which is very often liable to grind and always makes the arm work hard and unpleasantly. This rifle has been fired twelve shots in five seconds, using the U. S. Government cartridges. The magazine is charged from the under side, and it can be done with equal facility by a right- or left-handed person. And as there are no holes or spring covers on the side, it is not possible to have it clogged by passing through brush or laying it on the ground or in trenches, etc. It is also much easier to load on horseback than any other gun, as there is more choice of position than when the opening is on the side. It can be loaded as a single-loader either top or bottom, leaving the magazine full at all times for an emergency. The drawing shows the working parts of the arm, in position after firing. The breech-block, A, is held firmly in place by the brace, C, which is pivoted and cradled on the hammer-pin and lock-frame. C is brought into place and firmly held by the links, B (only one shown), which are connected by strong pins to the guard-lever, D. It will be seen from the drawing that it is absolutely impossible to get the hammer to strike the firing-pin until the brace, C, is in its proper place. It will also be observed that it is impossible to disarrange the parts, as all are pinned and hinged together, and that there are no sliding surfaces.

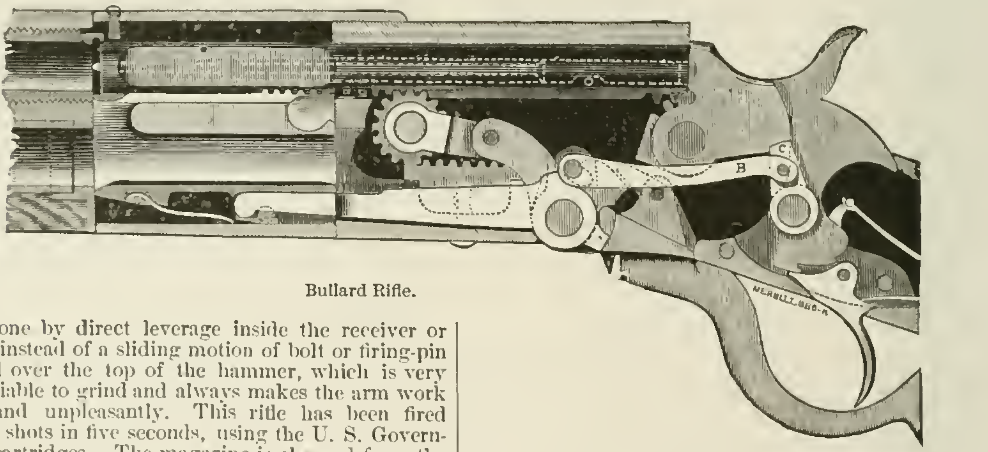
To dismount the gun, take out tang-screw: half-cock hammer and take out lock-frame and hammer-screws; pull out lock-frame down and backwards; disconnect links from brace; take out side-plate screws and remove side plate; remove carrier-lever spring; take out guard-lever bolt; take cut extractor-pin and remove extractor; push back pin before removing the bolt; draw out guard-lever with its connections; take out breech-block bolt; take out breech-block; draw out carrier-lever and take out carrier. The gun is assembled by reversed operations.

To remove the barrel, take out the magazine-plug screw and the two tip-screws, pull out the magazine-tube, and take off the fore-arm. If the bolt has not been previously removed, pull it back so as to prevent the breaking of the extractor while unscrewing the barrel.

To load the gun, carry the guard-lever forward as far as it will go, and then insert the cartridges in the magazine through the opening under the carrier.

To use the gun as a single-loader, carry the lever as far forward as is necessary to extract the spent shell, remove the shell, and insert another cartridge in the chamber of the gun; or, carry the guard-lever as far forward as it will go and insert a cartridge in the magazine through the opening under the carrier.

If the top cover is drawn back, the magazine can be quickly loaded by simply pressing against the under side of the carrier, which will force it up, exposing the entrance to the magazine, and also place the hammer at half-cock. See *Magazine-gun*.



Bullard Rifle.

BULL-DOG.—A refractory material used as a lining for the boshes of puddling or smelting furnaces. It is a decomposed protosilicate of iron.

BULLET.—The leaden projectile discharged from a musket, fowling-piece, pistol, or similar weapon. When the smooth-bore muskets alone were used, the bullets were made by casting. Molten lead was poured into molds; and the molds were dipped in cold water, to hasten the solidification of the lead. The molds were cooled after every few times of using; and the lead was heated only just to the degree for maintaining fluidity. Bullets are now, however, made more expeditiously, and more truly spherical in form, by compressing-machines, one form of which has been invented by Mr. George Napier. The lead is first fashioned into a rod about a yard long by five or six eighths of an inch thick; this rod is passed between rollers to condense it; then between other rollers to press it into a row of nearly globular pieces; then a spherical die gives the proper form to each of these pieces; and, lastly, a treadle-worked punch separates them into bullets. With one of these machines and two dies, nine boys can make 40,000 bullets in a day.

Spherical bullets for the old muskets, carbines, and pistols varied from 14 to 20 to the pound, and from .60 to .68 of an inch in diameter. There is a particular ratio, depending on the specific gravity of lead, by which the number to the pound will give the diameter, or *vice versa*. Such bullets are, however, becoming every year less and less used in the army, being superseded by other forms better suited for rifles. These forms are singularly numerous. Robins' bullet was egg-shaped, with the center of gravity at the larger end; Beaufoy's was ovoid, with a hemispherical cavity at one end; Manton's was a spherical ball put into a wooden cup, with projections on the exterior; Greener's was oval, with a plug of mixed metal driven into a hole barely large enough for it; Norton's, Delvigne's, Minié's, and others are, or were, of various elongated shapes, mostly with some kind of plug, which, driven into the lead by the force of the explosion, causes it to fill up the grooves in the rifling of the barrel. This expanding or dilating action has been claimed by many inventors; but the English Government in 1857 awarded Mr. Greener £1000, as the person who had practically solved the difficulty as far back as 1836. The bullets for the Enfield rifles are now made with extraordinary speed, by machinery of beautiful construction. The machine draws in a coil of leaden rod, unwinds it, cuts it to the required length, stamps out the bullets with steel dies, drops them into boxes, and conveys them away. Each machine, with its four dies, makes 7000 bullets per hour; and four such machines, in an easy day's work, turn out 300,000 bullets. So nearly are the machines automatic that one man can attend them all. Other machines, attended by children, produce an equal number of little boxwood plugs for filling the cavity at the hinder end of the bullet. See *Oblong Bullet*, *Percussion-bullets*, *Projectiles*, *Round Bullet*, and *Shot*.

BULLET-EXTRACTOR.—A pair of pinchers with projecting claws, adapted to imbed themselves in a bullet so as to draw it from its bed and extract it. When closed these form a smooth, blunt surface, like a probe, and are opened against the bullet so as to spread apart the vessels which might oppose the retraction.

BULLET-HOOK.—A hook-ended tool for extracting bullets. An iron bullet-hook was disinterred at Pompeii in 1819 by Dr. Savenko, of St. Petersburg. It was in company with a number of surgical instruments.

BULLET-LADLE.—One for melting lead to run bullets. It is usually a hemispherical ladle with a spout, but in one case the ladle has a hole in the bottom guarded by a spring plug and operated by a trigger on the handle; in another case a part of the ladle is covered, and the lead thus flows out at a guarded opening which keeps back the dross of oxide.

BULLET-MOLD—BULLET-MOULD.—When the smooth-bore muskets alone were used, all bullets were made by casting or molding. Molten lead was poured into molds of the desired shape; and the molds were dipped in cold water, to hasten the solidification of the lead. The molds were cooled after every few times of using; and the lead was heated only just to the degree for maintaining fluidity. Very few bullets are molded at the present time, since they are made more expeditiously, and truer in form, by compression. When molding, use 1 part of tin to 16 of lead, and keep the molds very hot and the handles tight together. It often happens that the handles become too hot for comfort and are not held together properly. The result is a bullet that is not round and one that will not fit the shell. See that the grooves of the bullets are filled with beef-tallow or Japan wax; wipe off all surplus grease before loading. When pressing the bullet into the shell, see that it is forced into the chamber of the reloading tool as far as it will go.

The drawing represents an effective mold. The

Bullet-mold.

melted lead is poured into the mouth at the top, is trimmed just as solidification begins, and the mold is locked by pressing the handles towards each other. After solidification the handles are pressed apart, the mold opens, and the bullet is withdrawn. After the bullet is taken from the mold it is swaged in a die to the proper size and shape.

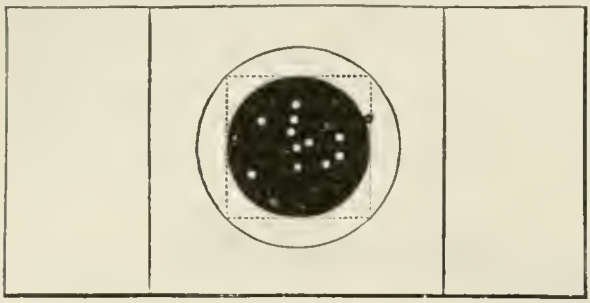
BULLET-PROBE.—A sound for exploring tissue to find the situs of a bullet. It is usually a soft steel wire with a bulbous extremity. Nelaton used a sound with a file-like extremity which might receive traces of the bullet, in cases where there is doubt of the character of the body with which it is brought in collision. He afterwards used a *sonde* with a termination of an olive-shaped body of white unvarnished porcelain, which would receive a black mark by contact with the bullet.

BULLET-SCREW.—A screw at the end of a ramrod to penetrate a bullet and enable the latter to be withdrawn from the piece. See *Ball-screw*.

BULLET-SHELL.—An explosive bullet for small-arms. Jacobs's bullet-shells, used with the rifle of General Jacobs of the East India service, have an inclosed copper tube containing the bursting-charge, which may be of fulminate or common powder, and is exploded by a percussion-cap or globule on striking In experiments made with them at Enfield in 1857, caissons were blown up at distances of 2000 and 2400 yards, and brick walls much damaged at those distances by their explosion.

BULLOCK.—This beast is admirable for slow draught, especially over rough roads, or through forests, or other places where there are no roads. Bullocks stand fire better than any other animals, and used to be employed in India for draught in field-batteries. They must not be hurried; their ordinary pace is from 2 to 2½ miles an hour. If used over hard roads they require shoeing. They need but little care, and thrive on poor food. They attain their prime at six years; the age is known by the annular swelling on the horns, allowing three years for the first ring and one year for each of the others. They are at present used in many parts of India and elsewhere as pack-animals, and carry a load of 200 pounds with comparative ease. See *Draught-animals* and *Pack-animals*.

BULL'S-EYE.—In gunnery and archery, the center of the target. In England the bull's-eye is a black rectangular figure on a white ground which is painted on targets, varying in size according to the distance at which the target is placed, and according to the class of marksmen firing at it. Outside the bull's-eye is a white space bounded by rectangular black lines. The space within these lines and between them and the bull's-eye is called the center. Outside these lines is the remainder of the target. In the United States the smallest circle, always painted black, is called the bull's-eye. The ring embraced between the bull's-eye and the circumference of the next larger circle is called the *center;* and the ring between the second and third circles (regulation target) is called the *inner*, the space outside the larger circle being called the *outer*. In the target represented, the space between the second circle and the vertical lines is the *inner*, and the space outside the vertical lines is the *outer*. See *Targets*.



Bull's-eye.

BULWARK.—The old name for a rampart or bastion. In a ship the bulwarks are the boarding above the level of the upper deck, nailed to the outside of the timber-heads and stanchions. In ordinary vessels they form a parapet, protecting the seamen from the waves, and prevent loose articles from being swept off the deck; in men-of-war they, in addition, serve to protect the men from an enemy's shot. In an inquiry made a few years ago concerning the availability of merchant-steamers as ships of war, it was found that the bulwarks would not afford sufficient protection to the men from musket-shot; but that if hammock-stanchions were fixed all round the bulwarks, and the men's hammocks placed in a netting upheld thereby, a very good protection might be obtained.

BUMFORD GUN.—A celebrated gun cast at South Boston in 1846. It is a 12-inch smooth-bore, having the following particulars:

Total length................	134.00 inches.
Length of bore and chamber.	116.20 "
Diameter over the chamber..	38.20 "
Weight.....................	25,510 lbs.

Before it was hooped the greatest enlargement of the chamber with 20, 25, and 28 pounds of powder and a 150-pound shell, after ninety-three fires, was .005 inch, and the greatest enlargement at the lodgment of the shell .074 inch. The maximum range in ricochet-fire, with 181-pound shell and 28 pounds of powder, was 5800 yards. This gun was hooped in 1862 with wrought-iron rings about 1 inch wide each, making a reinforce 31¾ inches long, 4 inches thick, and 46 inches in total diameter.

BUNG-STOPPERS.—In submarine mining, bung-stoppers are the contrivance for closing the hole in the case through which the charge is inserted, and through which the insulated wires pass from the fuse to the cable leading to the fort. The essential condition to be fulfilled is to have it water-tight and keep the arrangement in proper condition for ignition at any moment required; it should likewise be capable of being unscrewed, so that the fuse may be taken out for examination and replacement if defective.

Various forms of stoppers have been devised, the principal feature of each being a stuffing-box, in which gutta-percha packing is used. When regularly-constructed mines are supplied for service, stoppers will accompany them. For extemporized mines, any device which will hold the insulated wires and at the same time keep the water from the charge will answer. A composition composed of 1 part of tallow, 8 of pitch, and 1 of beeswax will be found good for tightening the joints. It becomes plastic at about 150 F. The addition of a little gutta-percha hardens the composition and renders it less liable to be affected by atmospheric heat.

BUNK.—The term employed by soldiers for a bed, or place for bedding.

BUNTINE.—A thin woolen material, of which flags and signals of stations are made. Also written *Bunting*.

BUOYS.—Buoys are used for temporarily marking the positions of mines, circuit-closers, etc. Small nut-buoys of iron are the best; but when these are not to be had, empty casks, such as beer-kegs, well lashed with rope, are convenient to handle, and answer every purpose. In all cases they must be sufficiently large, or have enough of flotation, to secure the mooring-cable or other object which they are intended to hold.

BURDEN OF PROOF.—In legal procedure, the obligation to establish by evidence certain disputed facts; and, as a general rule, this burden lies on the party asserting the affirmative of the issue to be tried or question in dispute, according to the maxim, *Ei incumbit probatio qui dicit non qui negat;* that is, proof is incumbent on him who asserts, not on him who denies. The principle of the law is that the burden of proof is on the party who would fail if no evidence were adduced on either side. Accordingly, it almost always rests on the plaintiff in an action, or on the party asserting the facts on which the result of the litigation must depend. In one case tried before the late Baron Alderson, that learned Judge laid down that the proper test was, *Which party would be successful if no evidence at all were given?*—the burden of proof, of course, falling on the party not in that position. This test has since been generally adopted and applied; but Mr. Best, in his work on the *Principles of Evidence*, improves on it by the suggestion that in strict accuracy the test ought to be, "Which party would be successful if no evidence at all, *or no more evidence*, as the case may be, were given?"—a consideration on which the discretion and judgment of counsel frequently depend. But although such, in general, is the position of the plaintiff, it sometimes happens that the burden of proof is imposed on the defendant, and in consequence of his having the affirmative of the material issue to be tried.

It is this rule as to the burden of proof that demonstrates the real nature of the plea of *Not Guilty* in a criminal prosecution, and which divests that plea of the objections to it which are frequently heard expressed by overscrupulous sentimentalists; for the meaning of that plea is not necessarily an assertion by the prisoner that he is absolutely guiltless or innocent, but that he wishes to be tried, and that as the burden of proof is on the prosecutor, while he has meanwhile the presumption of innocence in his favor.—Besides the work referred to, see on the subject of this article Starkie on the *Law of Evidence in England*, and Dickson on the same subject in Scotland.

BUREAU OF MILITARY JUSTICE.—In the United States service this Bureau consists of one Judge Advocate General, with the rank, pay, etc., of Brigadier-general. The reports which the Judge Advocate General may make upon cases requiring the action of the President are addressed to the Secretary of War, and forwarded through the General of the Army, for such remarks and recommendations as he may see fit to make. The original proceedings of all General Courts-Martial, Courts of Inquiry, and Military Commissions, after the decision thereon of the reviewing authority, and all proceedings that require the decision of the President under the Articles of War, and copies of all orders confirming, disapproving, or remitting the sentence of Courts-Martial or Military

Commissions, are forwarded direct to and filed in the Bureau of Military Justice. Communications relating to questions of military justice, or proceedings of Military Courts, upon which the opinion of the Judge Advocate General is desired, are forwarded through proper channels to the Adjutant General when such questions cannot be decided by an intermediate authority. Questions of an abstract, general character are not considered. Judge Advocates forward to the Judge Advocate General, at the end of each month, a list of all cases tried and to be tried within their jurisdictions. See *Judge Advocate General.*

BUREAUX OF THE WAR DEPARTMENT.—During the absence of the Chief of any Military Bureau of the War Department, his duties in the Bureau, prescribed by law or regulations, devolve upon the officer of his Department empowered by the President to perform them in his absence. See Military Departments throughout this work under appropriate headings

BURGESS MAGAZINE-GUN.—This gun belongs to that system in which a fixed chamber is closed by a bolt, sliding in line with the axis of the barrel, and operated by a lever from below. The bolt is a single piece, the rear of which serves as a guide to its motion by sliding in grooves on the inner surface of the receiver. The bolt is locked by the interposition of a portion of the breech-bolt lever, between its head and the rear of the receiver. The firing-pin, which is in this portion of the lever, passes through the pivot and prevents it moving either way. The firing-pin is retained in the lever by a screw. The ejector lies in a groove across the front of the bolt, just below the firing-pin hole; its rear terminates in a split spring, which, by friction against the side of an undercut groove in the side of the bolt, retains it in position. The ejector is driven forward against the under side of the head of the cartridge, when the lever is thrown open by its rear striking against a shoulder on the inner rear surface of the receiver. The bottom opening in the receiver is closed by a plate, called the lever-guide; its rear is terminated by a piece the tenon of which enters a corresponding mortise in the plate. An elongated hole in the tenon, through which passes the pin connecting the pieces, permits motion of the smaller part to and from the plate. A spiral spring is comprised between the two pieces. The motion of the lever in opening and closing is a sliding one. The carrier is pivoted on two short screws through the sides of the receiver. It is operated by a hooked projection on the bolt-head, which, sliding under it, supports it until the forward motion of the lever is nearly completed, when, by striking against the surfaces, the carrier is rotated about the pivot-screws, its front descending opposite the mouth of the magazine, which is in the tip-stock. When the lever is closed, the projecting hook, passing out of the recess, slides under the carrier, raising it to a position parallel to the axis of the barrel, when its upward motion is limited by pins projecting from the inner surfaces of the receiver. The hammer is cocked by the backward motion of the bolt when the lever is thrown forward. The piece is fired by a center-lock of the usual pattern. The magazine is loaded through a side cover in the receiver. No wiping-rod is provided, and there is no cut-off to the magazine. As a magazine-gun, three motions are necessary to operate it, viz , opened, closed, fired. As a single-loader, four motions are necessary, viz., opened, loaded, closed, fired. This gun carries ten cartridges in the magazine and one in the chamber. See *Magazine-gun.*

BURGONET.—A helmet that dates from the end of the fifteenth century. It has a rounded crown with a crest, and is distinguished by a shade over the eyes, cheek-pieces, and a neck-guard. Also written *Burganet* and *Burgonette.*

BURGOYNE.—An instrument formed by the combination of a spade, axe, and mantlet. It is intended to form a portion of the equipment of a soldier, and to be used for digging rifle-pits, etc. When used as a mantlet against bullets, the soldier fires through a small hole in the blade. The handle is jointed to facilitate packing.

BURLEY.—A common name for the butt end of a lance.

BURNING.—Joining metals by melting their adjacent edges, or heating the adjacent edges and running into the intermediate space some molten metal of the same kind. The process differs from soldering in this: In burning, a heat is required sufficient to melt the original metal, and a flux is seldom used. In soldering, a lower heat is used and a more fusible metal employed, assisted by a flux. The superior quality of *burning* arises from the fact that the joint will withstand the same heat as the body of the article. Cast-iron is frequently united by burning. It was first practiced by the native smiths of India and China, who occasioned much surprise to their Occidental neighbors by the way in which they mended cast-iron kettles and pots which were supposed to be irretrievably ruined. The first notice of it by Europeans appears to have been by Van Braam, in 1794–95, who was attached to the Dutch Embassy at Pekin, and who afterwards settled in the United States.

BURNISHING.—The process of giving a peculiar luster to a gun-barrel or other part of a rifle by rubbing it with a piece of steel. It is generally forbidden in the service as injurious to the gun.

BURNS AND SCALDS.—These injuries are not unfrequent in the laboratory and field. They are much the same in both cases; therefore the directions for the treatment of burns will be applicable also to scalds. These injuries may be divided into three classes: 1. Burns resulting in simple redness of the skin; 2. Burns resulting in vesication or blistering; 3. Burns resulting in sloughing, or death of the part. The first object, after the accident has occurred, is to relieve the suffering; and cold applied either in the form of ice or water seems in most cases to have almost a specific power in allaying pain and checking the advance of inflammation. In other cases moderate warmth is found more efficacious, and we must be guided mainly by the sensations of the sufferer as to which of these remedies we make use of. In very severe cases opium or chloroform may be employed. But if the injury the body has received be very serious, the patient complains less of pain than of cold; he shivers, is much depressed, and must be well supplied with stimulants, to prevent his dying from the shock. The best local application is the Carron oil, which derives its name from the famous iron-works, where it has been used for many years. It consists of equal parts of olive-oil and lime-water, and should be applied on linen rags or cotton-wool. Blisters may be pricked and the contained serum allowed to trickle away, but on no account is the raised skin to be removed. The dressings should not be changed oftener than cleanliness requires; and as each portion of the old dressing is removed, it must at once be replaced with fresh, so that as little exposure as possible of the burned surface may take place. The main principle of treatment is exclusion of the air from the injured part; and so long as this is effected, it matters but little what remedial agent is employed. Great care must be taken in the treatment of a sore resulting from a burn, that the contraction of the scar does not cause distortion of the neighboring parts.

BURNSIDE CARBINE.—An arm formerly used in the military service. It has a movable chamber which opens by turning on a hinge. A brass cartridge-case is used which packs the joint and cuts off the escape of the gas. The advantages of this arm are its strength, waterproof cartridges, perfectly tight joint, and working machinery. Its disadvantages are the cost, and difficulty of getting the cartridges. When first made, the metallic case of the Burnside cartridge (either of brass or steel) was capped at the larger end with a lead ring. The case was slightly conical, with a small hole at the smaller end. The manner of inserting the cartridge and extracting the shell after firing was similar to that employed at the present time. See *Carbine.*

BURNT UMBER.—A pigment of a russet-brown color. It is semi-transparent, mixes well with other pigments, and dries quickly. It is obtained by burning umber, an ocherous earth containing manganese, and deriving its name from the place where it was first discovered—Umbria, in Italy.

BURQUE.—A kind of cuirass which in ancient times was worn with the brigantine.

BURR.—1. In gunnery, a round iron ring which serves to rivet the end of the bolt, so as to form a round head. 2. Any roughness or unevenness observed in the barrels of guns after manufacture, or on balls which have been cast, or on the edge of tools when ground, or in wood-work when turned, caused by the inequality of the fibers of the material.

BURREL-SHOT.—A medley of shot, stones, chunks of iron, etc., to be projected from a cannon at short range. Frequently called *emergency-shot.*

BURSTING-BAGS.—Bags for the bursting-charges of common shell. In order to prevent the liability to occasional premature bursts when firing filled common shells from M.L.R. guns of 7-inch caliber and upwards, it has been found necessary to inclose the bursting-charge in a serge bag.

BURSTING-CHARGE.—1. A small charge of fine powder, placed in contact with a charge of coarse powder or nitroleum to insure the ignition of the latter. It is usually fired by voltaic means.—2. The charge of powder required for bursting a shell or case-shot; it may be poured in loose, or placed in a *burster-bag.*

BURTON.—A peculiar style of tackle. It has at least two movable blocks or pulleys and two ropes. The weight is suspended to a hook-block in the bight of the running part. This arrangement of cords and pulleys is susceptible of great variation, so as to increase in a twofold, fourfold ratio, or otherwise. Each pulley has but one sheave, and there are as many ropes as movable pulleys.

BURTON MAGAZINE-GUN.—In principle this gun does not differ from the Ward-Burton. The points of difference in construction are as follows: The joint between the body of the bolt and its head is transferred in this gun to the rear, so that the body of the bolt takes the place of the head, while the rear portion serves simply to lock it. As the body of the bolt does not rotate, the sear-bolt slot at right angles to its axis is dispensed with, giving, it is claimed, a stronger bolt. The extractor, though called a lever-extractor, is a spring hook pinned to the bolt near its front. The rear of the extractor is thickened so as to bear against a cam on the firing-pin, which prevents the descent of its rear with the corresponding rise of its front. In withdrawing a shell the spring can only be from the front portion alone. The trigger-spring serves also to hold the carrier in place. The carrier is composed of two principal parts, separated at front by a flat spring. The lower portion, which is pivoted at its rear to the upper, has on its front a sort of finger, which may be made to pass through a slot in the upper portion so as to project partly across the mouth of the magazine, cutting off the escape of cartridges by simply turning a set-screw in rear of the pivot. The motions are the same as in the Ward-Burton. This gun carries eight cartridges in the magazine and one in the chamber. See *Magazine-gun.*

BUSBY.—The head-dress worn by the artillery and hussars in the British army. It consists of a fur hat, with a bag hanging from the top over the right shoulder. The bag, which is made of the same color as the facings of the regiment, appears to be of Hungarian origin, and intended to ward off a sword-cut. In India the artillery whose head-dress in Europe is a busby do not wear it, but are provided with wicker helmets covered with white cloth. The head-dress worn by the fusiliers is called a "busby," and is made of black raccoon-skin for the officers, and of seal-skin for the non-commissioned officers and men.

BUSHEL.—A dry measure for grain, etc. The quarter contains 8 bushels, and the bushel 8 gallons, the gallon measuring 277.274 cubic inches, and holding 10 pounds avoirdupois of distilled water. Hence the imperial bushel contains 80 pounds of water, and measures 2218.2 cubic inches. The old Winchester bushel measured 2150 cubic inches; hence 33 Winchester bushels equals 32 imperial bushels nearly.

The following weights and estimates are often valuable when purchasing supplies in the field: One bushel of wheat weighs 60 pounds; of rye, 58 pounds; of barley, 54 pounds; of oats, 42 pounds; of beans, 62 pounds; of peas and maize, 66 pounds; of potatoes, 60 pounds; of onions, 56 pounds. About 50 pounds of wheat and 30 pounds of oats go to the cubic foot. One cubic yard of well-pressed hay weighs 225 pounds; one cubic yard of straw weighs 145 pounds; one cubic yard of grain will average 20 bushels. The following numbers of bushels will safely go to the acre; wheat, rye, and beans, 25; oats, 45; barley, 37½; peas, 25; maize, 30; potatoes, 250.

BUSHING.—When a pure copper vent is fixed in a gun, the gun is said to be *bushed.* It is done by drilling a hole in the piece where the vent is usually placed, about one inch in diameter, and screwing therein a piece of wrought copper, with a vent of ⅕ of an inch through the center of it. There are two kinds of vent-bushes—a *cone* and a *through* vent. The first is used when the gun is new, and, if practicable, when re-vented; the latter when the cone of the bush is not sufficiently large to remove the wear round the bush.

BUSHING TENTS.—A method resorted to when the soil will not hold well, or in stormy, blowing weather. It is generally necessary under these circumstances to *bush* the main outer ropes of the tent, which is effected by burying to a sufficient depth under the ground a strong bush at each angle of the tent, to which ropes are attached.

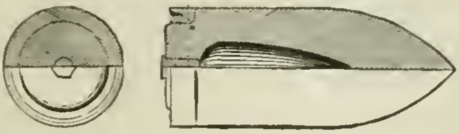
BUSHWHACKERS.—A term much in use in the War of the Rebellion (though well known before) to indicate men who pretended peace or neutrality, but who were ready to make secret attacks whenever opportunity offered. They were numerous in some Western States, where many of them were summarily shot as outlaws.

BUSKINS.—A kind of shoe, or half-boot, adapted to either foot, and formerly part of the Roman dress. They are now worn by some European armies. The ancient tragedians wore buskins (*cothurni*), often with thick soles, to add to their stature. Hence the buskin is often put for tragedy, as the sock (*soccus*, a flat-soled shoe) for comedy. In ancient sculpture, Diana, and hunters in general, as well as men of rank and authority, are represented in buskins often highly ornamented.

BUTIN.—Booty or pillage. At the beginning of the French Monarchy, and for a long time after its establishment, a particular spot was marked out by the Prince or General, to which all persons belonging to the victorious army were directed to bring every species of booty that might have fallen into their hands. This booty was not divided, or appropriated according to the will and pleasure of the Prince or General, but was thrown into different lots, and drawn for in common. The soldiers who distributed these spoils were called Butiniers.

BUTLER PROJECTILE.—This projectile consists of a cast-iron body having a double-lipped expanding ring attached by a screw-thread to its base. Upon discharge, the powder-gases entering the cannelure of the ring expand the outer lip into the grooves communicating rotation to the projectile, and pressing the inner lip tightly against the base of the projectile tends to prevent stripping. The ring may be of brass (75 parts of copper to 25 of tin) or of an alloy of copper, tin, and brass, the brass being fused with the copper.

The *Butler canister* consists of a hollow cylinder made



up of truncated iron wedges inclosed in an envelope of tin. The cylinder is closed at the bottom with a lead cup inclosing a disk of wood, and at the top with a sheet-iron plate, disks of tin being employed on the outside at both ends to facilitate soldering. The interior of the cylinder is filled with the round iron balls. See *Expanding Projectiles* and *Projectiles*.

BUTT.—1. In gunnery, a solid earthen parapet, to fire against in the proving of guns, or in practice. 2. That extremity of a musket which rests against the shoulder when the piece is brought up to the position of firing. The term *butt end* is usually employed in this sense.

BUTTERIS.—A knife with a bent shank, used by farriers to pare the hoofs of horses. It has a blade like a chisel, and is operated by a thrust movement, the handle resting against the shoulder. The term is probably from the French *boutoir;* provincial, *boutaran.* Some old Roman paring-implements of iron are yet extant.

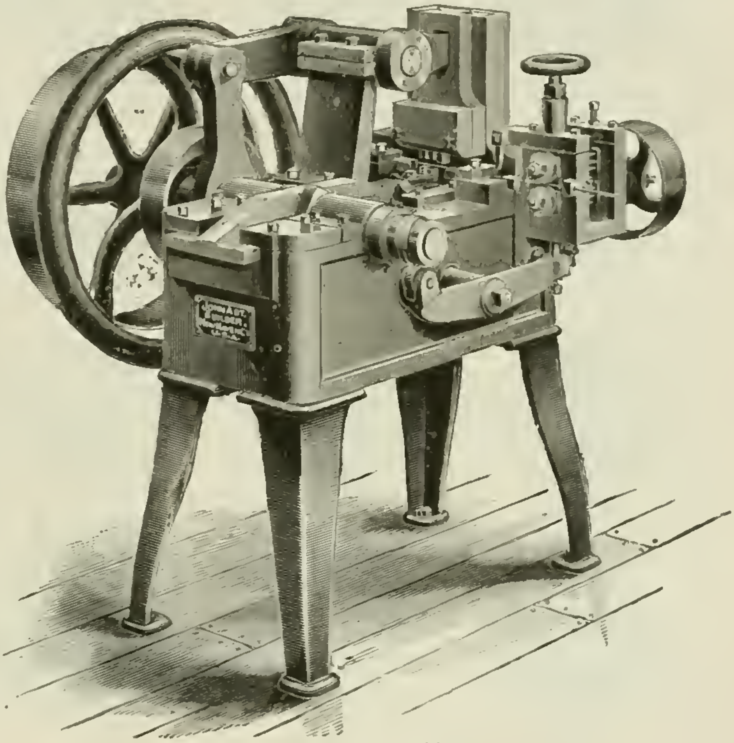
BUTTON.—1. In gunnery, a part of the cascabel, in either a gun or a howitzer, being the hind part of the piece, made round in the form of a ball.

2. A part of the uniform, used both for ornament and for buttoning. In the United States army the button is prescribed as follows:

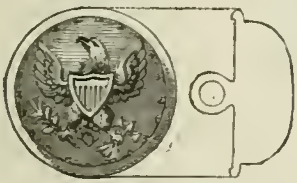
For General Officers, Storekeepers, and Officers of the General Staff.—Gilt, convex, with spread eagle and stars, and plain border; large size, seven eighths of an inch in exterior diameter; small size, one half inch.

For Officers of the Corps of Engineers.—Gilt, nine tenths of an inch in exterior diameter, slightly convex; a raised bright rim, one thirtieth of an inch wide; device, an eagle holding in his beak a scroll, with the word "Essayons," a bastion with embrasures in the distance surrounded by water, with a rising sun—the figures to be of dead gold upon a bright field. Small buttons of the same form and device, and fifty-five hundredths of an inch in exterior diameter.

For Officers of the Ordnance Department.—Gilt, convex, plain border, cross cannon and bombshell, with a circular scroll over and across the cannon, containing the words "Ordnance Corps;" large size,

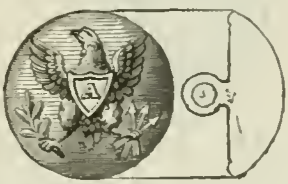


Button-shank Machine.



Staff.

Topographical Engineer.



Artillery.

Staff.

Artillery.

Engineer.

Cavalry.

Infantry.

Ordnance.

Maine.

New Hampshire.

Vermont.

Massachusetts.

Rhode Island.

Connecticut.

New York.

New Jersey.

Pennsylvania.

Maryland.

Virginia.

North Carolina.

South Carolina.

Georgia.

Alabama.

Mississippi.

Louisiana.

Texas.

Arkansas.

Kentucky.

Ohio.

Missouri.

Michigan.

Wisconsin.

seven eighths of an inch in exterior diameter; small size, one half inch.

For Officers of Artillery, Infantry, and Cavalry.—Gilt, convex; device, a spread eagle with the letter A, for Artillery—I, for Infantry—C, for Cavalry, on the shield; large size, seven eighths of an inch in exterior diameter; small size, one half inch.

Aides-de-Camp may wear the button of the General Staff, or of their regiment or corps, at their option.

For all Enlisted Men.—Yellow, the same as is used by the Artillery, etc., but omitting the letter in the shield.

The various State buttons, full size, are shown in the drawings above.

The history of button-making is in many ways a curious one. Dating no further back as a trade of any importance than the reign of Elizabeth, it has undergone several extraordinary changes, produced chiefly by the ever-varying fashions in dress, but also by some simple though ingenious inventions, as well as by foreign competition. In Great Britain, Birmingham has always been the principal seat of the button-manufacture. What has been called the "Augustan Age" of button-making in that city included the latter portion of last and the early part of the present century, when even tradesmen wore coats "loaded with innumerable gilt buttons," and when employers on a moderate scale in this manufacture were making incomes of from £2000 to £3000 a year, and their workmen from £2 to £4 per week. Early in the present century Mr. B. Sanders introduced the cloth-covered button, which initiated the change from those made of metal, and by which he rapidly made a fortune. His son in 1825 effected the apparently trivial but really ingenious improvement of making it with a canvas tuft instead of a metal shank, by which both the button-holes and the garment itself were less subject to injury. This kind of button had an enormous sale, and is still much used. A further alteration was made on it by Mr. W. Elliott, who patented in 1837 a mode of covering the button with silk, having a pattern in the center, the demand for which was at one time so great that sixty looms were employed in London in making the special material required for them. Metal buttons, although not relatively so important as formerly, have never ceased to form a prominent section of the trade. They are a numerous class, and include all sorts for uniforms, trouser-buttons, fancy buttons which are gilt, stamped, chased, or enameled, and many cheap varieties in iron and other metals for export. Numerous kinds of composite buttons are also partly composed of metal. Glass buttons form another interesting branch, carried on to a considerable extent in Birmingham, but more largely in Bohemia and Paris; so also do porcelain buttons, which, although an English invention, are now almost exclusively made in France. Vulcanite buttons have been extensively made in the United States. As to other materials, a Birmingham manufacturer says it were easy to write out a long list from which buttons have been made, but very difficult to name one from which they have *not* been made.

Briefly described, the processes in making the military brass buttons are as follows: Circular disks, called "blanks," are first cut out of sheet-brass or other metal by means of fly-presses, usually worked by girls. The fly-press consists of a vertical iron screw with a triple thread, to which screw is attached a horizontal arm, bending downwards at the end to form a handle. A punch attached to the press rises and falls with the motion of this handle, and rapidly cuts out the blanks. When large quantities of one pattern are required, a self-feeding, self-acting machine is used, which cuts out the blanks in rows at one blow, turning them out at the rate of 2000 gross per day. After being annealed, the blanks are next made convex by a blow from a stamp. The shanks are formed of wire by a separate machine shown in the drawing, which cuts off pieces and bends them into loops of the required form. When these are soldered on, the buttons are dressed on a lathe. They are then gilded and burnished; some, however, are only lackered; and some, though gilt, are finished in a dead or frosted style.—"Shell" buttons are those with a convex face, a flat or convex back, and hollow. These are made of two blanks, that forming the face being larger than the back to which the shank is attached. These blanks are pressed into the required shape by dies worked in the fly-press, and then, by another die, the edge of the larger blank is lapped over the smaller, and thus attached without soldering. Military and other buttons having a device in strong relief are stamped by a die placed in a stamping-press.

BUTTRESS.—A counterfort or sustaining wall or pillar, built against and at right angles to the wall to which it forms a revetment. In the classical style there were no buttresses, their place being to a certain extent supplied by pilasters, antæ, etc. The different stages of Gothic architecture are marked by the form of buttresses employed, almost as distinctly as by the form of the arch. The Norman buttress was broad, often semicircular, sometimes dying into the wall at the top, and never projecting from it to any great extent. Early English buttresses project much more boldly, and are considerably narrower, than the Norman. They are frequently broken into stages, which diminish in size as they ascend. In the decorated style, this division into stages is almost invariable, the buttress being often supplied with niches terminating in pinnacles, and very highly ornamented with carving, statues, etc. In the perpendicular style they retain the forms which had been introduced during the decorated period, the ornamentation of course being varied to suit the character of the style. Flying-buttresses—i.e., buttresses in the form of a sloping arch, connecting the upper and central portions of an arched structure with the vertical buttresses of the outer walls—were introduced into England at the period of the early English, though they existed on the Continent previously, where they continued to be used to a greater extent. They were also very common in Scotland. In England they are generally called arch-buttresses.

BYL.—One of the early Norman arms, resembling a war-hatchet. Now obsolete.

BYRNIE.—A name applied to the very ancient English body-armor. Now obsolete.

BYSSA.—An ancient cannon for throwing stones. The byssa was a formidable weapon in its time.

C

CABACLE.—A military coat worn by the modern Grecians. Now obsolete.

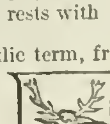
CABAL.—A term employed to denote a small, intriguing, factious party in the State, and also a union of several such, which, for political or personal ends, agree to modify or sacrifice their principles. The word was used to describe an English Ministry in the reign of Charles II., the initials of whose names composed CABAL—viz., Clifford, Ashley, Buckingham, Arlington, and Lauderdale. This was not the origin of the word, however, as some have supposed, but merely the ingenious application of a word previously in use, and which appears to have been derived from the French *cabale*, possessing a very similar signification.

CABAS.—1. A basket made of rushes, used in ancient Languedoc and Roussillon for the purpose of conveying stores and ammunition. 2. A large shield or buckler which served to protect the archers who attacked in intrenchments.

CABASSET.—The common infantry head-piece in the sixteenth century. It was a light *morion*, or iron cap, with a wide brim that was much lowered. It was frequently called *cervelière*, because it only covered the upper part of the head. Also written *Cabacet* and *Capacète*.

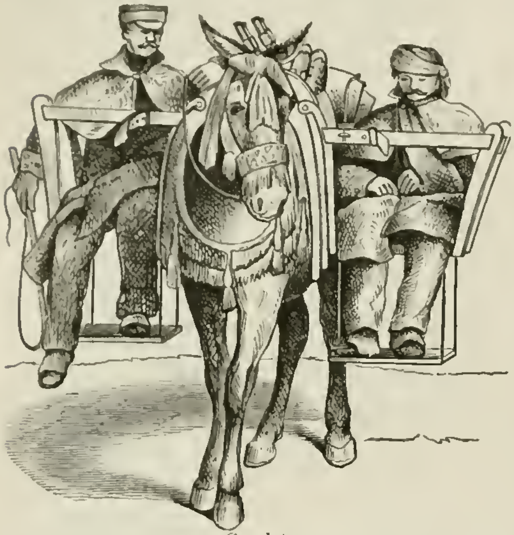
CABINET.—The Heads of Departments who are the immediate advisers or counselors of the Chief Executive. In the United States the Cabinet consists of the Secretaries of State, Treasury, War, Navy, and Interior, the Attorney General, and the Postmaster General. They meet whenever desired by the President, but not publicly. No minutes are kept of their doings, nor are the names of those present recorded. The President presides; and he may at any time require in writing the opinion of any of the members upon matters concerning his Department. But the Cabinet has no responsibility, as that rests with the President alone.

CABOCHED—CABOSSED.—An heraldic term, from the old French word *caboche*, meaning the head. When the head of an animal is borne, without any part of the neck, and exhibited full in face, it is said to be caboched or cabossed. See *Heraldry*.



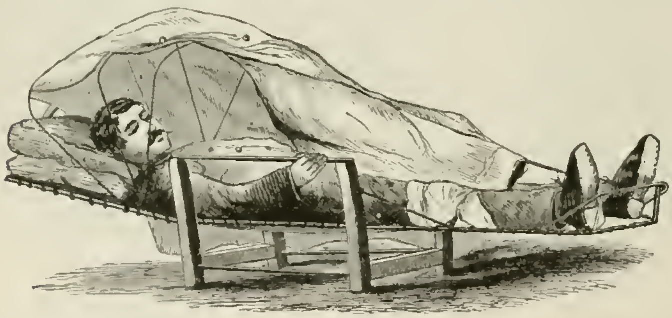
CABULE.—A machine of war, used in early times, but mostly during the twelfth century, to throw stones

CACHE.—A hiding-place, usually a cavity, natural or artificial, in the ground or among rocks, where voyagers, explorers, and troops stow provisions or records, to be found by themselves or others. If containing provisions, the cache needs to be very strong



Cacolet.

to resist the depredations of animals. The name was early used by parties of travelers in the great Western Prairies of the United States. Designing to return on their tracks after crossing the Rocky Mountains, they disburdened themselves of whatever articles could be



Cacolet-litter.

spared, and, to conceal them from the Indians, constructed places of deposit in the wilderness. The making of a cache is a matter of much labor and ingenuity. A hole is dug to a depth of perhaps 6 or 8 feet and several feet broad, and then the articles being interred, the surface is replaced with the utmost possible care. The excavated earth is also carefully removed, so as to leave no trace whatever of the excavation. The situation of the cache, however, is known to the party by some landmark, and returning months afterwards, they probably find its contents undisturbed.

CACOLET.—A folding-chair made to be slung on a pack-saddle, one on each side of an animal. They are used for carrying the sick or wounded in the day of battle. The most approved pattern weighs 56 pounds the pair. The pack weighs the same. Add the weight of two men, say 150 pounds each: total weight to be carried, more than 400 pounds—rather an excessive weight for any but a large-built mule or horse. The drawing shows some of the details of the French and British Crimean *cacolets*. This nature of chair is very tiring for the sick man, and it is, moreover, very difficult to place him in the *cacolet*.

In 1861 the United States Quartermaster's Department purchased a number of *cacolets* of the pattern used in the French army, and employed a French agent to give instruction in their use, and purchased animals specially adapted for their transport. The Quartermaster-general has remarked that these horses and mules were gradually appropriated as draft-animals, and that the *cacolets* were, for the most part, condemned as unserviceable.

A very convenient litter used by the French, under favorable circumstances, but never satisfactorily tested in the United States, was so constructed as to be readily detached from the pack-saddle and unfolded to form a comfortable bed for the patient. This like all other forms of *cacolet* has been considered unsuited to the requirements of field-service in this country. Scarcely a word in favor of them is to be found in any reports of the Medical Directors or Field-surgeons. See *Ambulance*.

CADASTRAL.—A term derived from the French word *cadastre*, a register of lands, or from *cadrer*, to square, and signifying a survey on a large scale, such as has been adopted of late years on the Continent of Europe, and is now used in England in the ordnance maps. The measurement corresponds so nearly to 25 inches to the mile that it is usually spoken of as the 25-inch scale. It has the further advantage of bearing, within a very small fraction, the proportion of one inch to an acre. A cadastral as opposed to a topographical map may be defined to be one on which the subjects represented agree, as to their relative positions and dimensions, with the objects on the face of the country; while a topographical map, drawn on a small scale, exaggerates, for the sake of distinctness, the dimensions of houses, and the breadth of roads and streams, and is, owing to its smaller size, necessarily less correct than a cadastral plan.

CADENCE.—1. A uniform time and pace in marching, indispensable to the correct movements of troops in large bodies. 2. In music, cadence is the finish of a phrase, of which there are three principal species, viz., the whole, the half, and the interrupted cadence. The whole cadence, which finishes on the harmony of the tonic, is also called the perfect cadence, and is always used at the end of a composition, and frequently called the final cadence. In its most perfect use it consists of three chords—the one before the final being always the dominant. The half-cadence, also called the imperfect cadence, isused to mark the termination of an idea or phrase, like the colon and semicolon; showing a considerable division, but at the same time that a continuation is necessary. The harmony of the half-cadence is

Cadences.

the reverse of the whole cadence, as it falls from the tonic to the dominant, and sometimes to the subdominant as in *a*. In the interrupted cadence, the preparation for the ordinary perfect cadence is made; but instead of the harmony of the tonic following the dominant, another harmony quite strange is introduced, so that the ear is deceived. The more particular the preparation for the usual cadence is made, the more strange and unexpected is the interruption, which can be made in so many ways that Reicha, in his *Traité de Haute Composition Musicale*, gives 129 interrupted cadences. Those generally in use are written in *b*.

CADENCY.—The marks by which the shields of the younger members of families are distinguished from those of the elder, and from each other, is an extensive, and, in so far as that term can be applied to Heraldry at all, an important branch of the science. No distinction is usually made by writers on Heraldry, and probably the practice of heralds in general scarcely admits of any being made, between *marks of cadency*, *differences*, *distinctions*, or even *brisures*, though the last term is pretty constantly, and quite appropriately, used to include not only differences in general, but also abatements or bearings by which the arms of the family are broken or diminished. But there is a manifest convenience in the practice which is usually followed in Scotland of appropriating the label, the crescent, the mullet, and the rest of the series of marks, commonly known as marks of cadency, to the purpose of distinguishing the sons from the father, and from each other, during the father's lifetime; and of adopting other distinctions—such as the bordure of various kinds, the chief engrailed, embattled, and the like, as differences between the coats of brothers, after the death of their father, and of the houses descended from them. Another very common mode of differencing the shields of brothers in early times was by changing the tinctures; but this is now regarded as too extensive a change for such a purpose. The method of differencing by means of the ordinary marks of cadency will be understood from the accompanying illustration. Fanciful reasons have been imagined by heralds for assigning these different

Distinction of Houses:

In the First House, the first, second, etc., sons are denoted by 1, the label; 2, the crescent; 3, the mullet; 4, the martlet; 5, the annulet; 6, the fleur-de-lis; 7, the rose (not figured in the cut); 8, the cross moline; 9, the double quatrefoil. In the Second House, or family of the second son, the first son is denoted by (1) the crescent, with the label upon it; the second, by (2) the crescent, with the crescent upon it; and so on. In the Third House, or family of the third son, the first son is denoted by the mullet, with the label upon it; the second, by the mullet, with the crescent upon it; and so on.

marks to the different sons. The differences at present used by the royal family will be found in most of the peerages. The rule with regard to them seems to be that, unlike subjects, they all bear the label of three points argent; but the label of the Prince of Wales is plain, whilst those of the other princes and princesses are charged with crosses, fleurs-de-lis, hearts, or other figures, for the sake of distinction. One of the most frequent reasons for matriculating the arms of the younger branches of families of distinction in the Lord Lyon's Register, is that they may be properly distinguished from those borne by the head of the house. See *Heraldry*.

CADET.—A term applied in a general sense to a junior member of a noble family as distinguished from the eldest; and in France, any officer junior to another is a Cadet in respect to him. In a strict military sense, however, a Cadet is a youth studying for the public service. In England, military cadetship has presented two aspects, according as it is related to the East India Company's or to the Royal service. When the Company possessed political and military authority in India, there were about 5000 English officers in their pay. Those who commanded the Company's own regiments had been professionally educated by the Company. A youth, nominated by the Directors, was examined as to his proficiency in an ordinary English education, and admitted between the ages of 14 and 18 to Addiscombe School or College, near Croydon. If a probation of six months resulted satisfactorily, he entered upon a two years' course of study. If he passed through this ordeal well, he became a Cadet in the Company's service, receiving pay or salary, and being available for service in India, as opportunity might offer. The system of Indian cadetship underwent various modifications by the introduction of competition in the appointments, and by the transference of the Company's powers to the Crown; and ceased in 1861, when the accession of fresh officers to the local Indian armies was stopped. The second aspect of military cadetship in England, adverted to above, is that of the Royal or Queen's Cadets.

Cadets at the United States Military Academy are subject to the Rules and Articles of War. Each Cadet, upon his admission, is required to take the oath of office prescribed by Act of Congress of July 2, 1862, and *before receiving his warrant* shall, in the presence of the Superintendent, or of some officer deputed by him, subscribe to an engagement in the following form:

I, ——— ———, of the State of ———, aged ——— years ——— months, having been selected for appointment as a Cadet in the Military Academy of the United States, do hereby engage, with the consent of my (Parent, or Guardian), in the event of my receiving such appointment, that I will serve in the Army of the United States for eight years, unless sooner discharged by competent authority. And "I, ——— ———, DO SOLEMNLY SWEAR, that I will support the Constitution of the United States, and bear true allegiance to the National Government; that I will maintain and defend the sovereignty of the United States paramount to any and all allegiance, sovereignty, or fealty I may owe to any State, county, or country whatsoever; and that I will at all times obey the legal orders of my superior officers and the rules and articles governing the armies of the United States."

——— ———.

Sworn and subscribed to, at ———, this ——— day of ———, eighteen hundred and ———, before

——— ———.

The punishments to which a Cadet is liable are comprised in the three following classes, viz.: 1st. Privation of recreation, etc.; extra duty (not guard); reprimands; arrests, or confinement to his room or tent, or in the light prison; reduction of officers or non-commissioned officers. 2d. Confinement in dark prison. 3d. Suspension; dismission, with the privilege of resigning; public dismission. The punishments of the first class mentioned may be inflicted by the Superintendent; those of the second class only by virtue of the sentence of a General Court-Martial, except in cases of mutinous conduct, or breach of arrest; and those of the third class only by the Secretary of War.

When a Cadet shall receive a regular degree from the Academic Board, after going through the classes, he is considered as among the candidates for a commission in the Engineers, Ordnance, Artillery, Infantry, or Cavalry, according to the duties he may be judged competent to perform. General Winfield Scott said: "I give it as my fixed opinion that, but for our graduated Cadets, the war between the United States and Mexico might, and probably would, have lasted some four or five years, with, in its first half, more defeats than victories falling to our share; whereas, in less than two campaigns, we conquered a great country and a peace, without the loss of a single battle or skirmish." See *Royal Military Academy, Sandhurst, Staff College*, and *United States Military Academy*.

CADETS' COLLEGE.—A college with this designation was established in 1858 by a remodeling of the Junior Department of the Royal Military College at Sandhurst. Its objects were to give a sound military education to youths intended for the army, and to facilitate the obtaining of commissions when the education was finished. The age of admission was between 16 and 19. The friends of a youth able to pay the sums of money presently to be named applied to the Commander-in-Chief for permission to place the youth on the list of Candidates; this permission was usually granted on production of satisfactory certificates and references. The youth might go up for examination on any half-year. The list of subjects included English composition, Continental languages, mathematics, history, geography, natural sciences, experimental sciences, and drawing. After the examination, the Candidates were reported to the Commander-in-Chief in their order of merit. Those who had the most marks were admitted as Cadets as soon as vacancies occurred in the College. When entered, they studied for two years on a great variety of subjects connected with military science and practice. The friend supplied clothing, books, and instruments. The annual payment for education, board, and lodging varied from £100 per annum down to £20; the highest sum being demanded for "the sons of private gentlemen," while the lowest was deemed sufficient for "the sons of officers of the army or navy who had died in the service, and whose families were proved to be left in pecuniary distress." Twenty of the youths were "Queen's Cadets," sons of officers "who had fallen in action, or had died from the effects of active service, and had left their families in reduced circumstances." These twenty Cadets were admitted and educated gratuitously. This system was abolished in 1870. Sub-lieutenants of cavalry and infantry, styled "Student Officers," who have done duty with a regiment for about 12 months, are now required to attend the College at Sandhurst, and go through a course of study for a year. At the end of it, on passing a satisfactory examination, they are promoted to the rank of Lieutenant, and rejoin their regiments.

CAGE DE LA BASCULE.—A space into which one part of a drawbridge falls, whilst the other rises and conceals the gate.

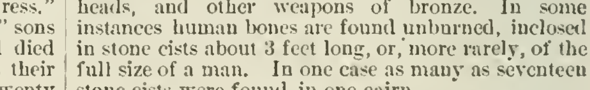
CAIMACAN.—A Turkish officer corresponding with Lieutenant or Lieutenant-governor. The Caimacan of Constantinople is the Lieutenant of the Grand Vizier, whom he represents in processions. Such officers also act as Governors in the principal towns. Also written *Kaimakam*.

CAIRN—CARN.—A Celtic word, signifying a protuberance, a heap, a pile. In that sense it appears in the names of hills and other natural objects in Scotland, Ireland, Wales, Cornwall, and Brittany. It is also applied to artificial heaps of unhewn stones, which, among archæologists, have come to be generally known as "cairns." There are several kinds of cairns. The simplest and most common form seems to be a conical pile of stones of no great size. Next is what may be called the fence or ringed cairns—a heap of stones girdled round by large unhewn stones set upright in the ground. Some cairns have two and a very few have three such concentric girdles; in some instances there are concentric rows of upright stones within the cairn. Many cairns are found in the neighborhood of the circles of unhewn stone pillars which antiquaries used to style "Druidical." In a few instances cairns are found at the end of an avenue of standing stones. Some cairns are fenced round by a narrow ditch and a small earthen rampart. A very few cairns have unhewn flat stones on their tops; a still smaller number are surmounted by an unhewn stone pillar. A few are oblong in shape. Cairns were erected, doubtless, for several purposes. It appears from record that they were often raised to distinguish the marches or boundaries of lands. One cairn, near Balmoral, on the Highland Dee, is said to have been erected as a mustering-place for the men of Strathdee, who took its name, *Cairn-na-cuimhne*, or "Cairn of Remembrance," for their slogan or war-cry. In later times, places where great crimes had been committed were marked by cairns; thus, "Mushet's Cairn," in the Queen's Park, at Edinburgh, shows the spot where a wife was murdered by her husband, under circumstances of peculiar atrocity, in 1720. But that the great purpose of the cairn was sepulchral is shown by the human remains found in so many of them. "*Disjectis et erutis, ossa inveniuntur, et quibusdam honor nominis adhuc manet*," says Robert Gordon of Straloch, writing of Scotch cairns in 1654. "For the cairns or heaps of stones in several parts of Ireland," wrote Thady O'Roddy in 1617, "some of them were heaped as monuments of battles, some made in memory of some eminent persons buried in such a place." A Highland suppliant would have said to his benefactor: *Curri mi cloch er do charne*—"I will add a stone to your cairn." The bones found in cairns are generally calcined or half-burned, and inclosed either in what are called *cists*—small rude coffins of unhewn stones—or in earns of earthenware, which, again, are in many cases protected by stone cists. Along with the bones are often found flint arrow-heads, flint axe-heads, stone hammers, stone rings, glass beads, implements of bone, bones of horses and oxen, spear-heads, and other weapons of bronze. In some instances human bones are found unburned, inclosed in stone cists about 3 feet long, or, more rarely, of the full size of a man. In one case as many as seventeen stone cists were found in one cairn.

CAISSON.—1. A carriage used to transport ammunition; in light field-batteries there is one caisson to each piece, in heavy batteries there are two. The ammunition is contained in three chests—two mounted on the body, and one on the limber. The number of rounds for each chest varies with the caliber of the piece, as follows, viz.:

6-pdr. gun and 3-inch rifle-gun..........	50
12 pdr. gun..........................	32
12-pdr. howitzer......................	39
24-pdr. howitzer......................	23
32-pdr. howitzer......................	15

The whole number of rounds for each piece may be ascertained by multiplying the above numbers by four. The caisson is composed of a *body* and a limber. The body is composed of one *middle* and two *side rails* (1), one *stock* (2), and one *axletree* (3). It carries two ammunition-chests (4, 5), a *spare wheel* (6), which fits upon an iron axle-arm attached to the rear end of the middle rail, one *spare pole* (7), fastened to the under side of the stock, and a *spare handspike*. The spare articles are needed to replace broken parts. The caisson also carries a *felling-axe*, *shovel*, and *pick-axe*, to remove obstructions, repair roads, etc., a *tarpaulin* strapped on to the limber-chest, a *tar-bucket*, and a *watering-bucket*. See *Field-carriages*.



Artillery Caisson.

2. In engineering, a hollow box of iron or wood,

open at the bottom, sunk where piers are to be placed. The largest caisson yet sunk was for the tower of the Brooklyn bridge on the New York side. At the bottom it was 172 feet long and 102 feet wide, with an air-chamber 9½ feet high, the roof 22 feet thick, and the sides carried up 82 feet from the lower edge. It had a cofferdam in the upper part; was built of timber lined with boiler-iron, and bolted together. In its construction there were used of lumber, board measure, 4,200,000 feet, and of iron, including bolts, 620 tons. When completed it weighed 13,271 tons, and there were 30,000 tons of masonry laid within it. There were two double air-locks extending into the air-chamber, in which were steam-pipes to keep an even temperature. Two shafts passed up through well-holes in the masonry, with an elevator in one and two spiral stairways in the other. Below the lowest edge of the caisson extended two water-shafts, each 7⅝ feet in diameter, in which dredges and scoops grappled the stones and soil, raising their loads to cars above, which conveyed the refuse away. At the same time sand and fine dirt were blown out by air-pressure through forty or more pipes in various parts of the structure. The interior was illuminated by gas, and constant communication by telegraph was kept up with the workmen inside. There were four shafts, each 2 feet in diameter, for the introduction of material for the concrete with which the whole interior was finally filled. The caisson was sunk 78 feet below mean tide, a work that required a presssue of 34 pounds per square inch in addition to the normal pressure of air; and to supply this addition, thirteen large compressors were used. The earliest caissons for such purposes were used in England in 1738–40 in laying the foundations of the Westminster bridge over the Thames.

CAKE-POWDER.—Gunpowder which has become lumpy from having imbibed moisture. In this state little permanent good can be done to it by reeling and redrying it, unless it is used at once, as after a time it absorbs more moisture than it did before; powder, therefore, in this state should not be re-stowed. This does not apply to pebble-powder, the grains of which are too large to cake.

CALABAS.—An early light form of musket with a wheel-lock. Bourne mentions it in 1778. Also written *Calabuss*.

CALATRAVA.—An order of knighthood in Spain, instituted at Calatrava. The statutes of the Order, framed by the Chapter-general of the Cistercian monks, were sanctioned by the Bishop of Toledo in 1164, and afterwards by the Pope. At subsequent periods many privileges were added. After the death of the king, their patron, some of the knights were no longer willing to obey the abbot, and they consequently separated themselves from the monks, and elected a Grand-master, Don Garcias de Redon. At a later period they again united themselves to the Cistercians, after they had gained rich possessions from the Moors both in Spain and Portugal. When Castile had fallen into anarchy, and the other kingdoms were exhausting themselves by internal feuds, the war against the unbelievers was almost entirely carried on by the Knights of Calatrava. Their almost uniform success, however, gave rise to rashness; the knights were defeated by Emir Jacob ben Yuseff, nearly all of them perished, and Calatrava was occupied by the Moors. After this disaster the knights transferred their seat to the Castle of Salvatierra, by the name of which they passed for a long time afterwards. A truce of twelve years having been concluded, during which the order was revived, the knights were able, at the battle of Las Navas de Tolosa, in 1212, again to turn the tide in favor of the Christians. They then returned to Calatrava.

CALCANS.—The bucklers of the Turks. These were worn and so called during the Middle Ages.

CALCINATION — CALCINING. — The process of heating or roasting in furnaces or in heaps the various metallic ores. It is resorted to as the first stage in the extraction of the majority of the common metals from their ores, and is essentially a process of oxidation.

CALCIUM.—The metal present in chalk, stucco, and other compounds of lime. It may be obtained by passing a powerful current of voltaic electricity through fused chloride of calcium ($CaCl$), when the metal separates in minute globules. It is a yellowish-white metal, can be rolled into sheets, and hammered into leaves, and is intermediate between lead and gold in hardness. It is represented by the symbol Ca, has the atomic weight or equivalent 30 (new system, 40), and has the density 1.578, or nearly half as heavy again as water. At ordinary temperatures it slowly tarnishes by oxidation; and when placed in contact with water it rapidly decomposes the water (HO), forming lime (CaO), whilst hydrogen escapes. To be retained bright, calcium must be kept under the surface of naphtha. At a red heat it melts and burns with a dazzling white light, accompanied by scintillations.

CALCULUS.—The infinitesimal calculus, otherwise sometimes called the transcendental analysis, is a branch of mathematical science which commands, by one general method, the most difficult problems in gunnery and physics. The merit of the invention of this powerful mathematical instrument has been claimed for Leibnitz, but is undoubtedly due with equal justice to Newton, who laid the foundations for it in that celebrated section of his *Principia* in which he demonstrates the chief theorems regarding the ultimate values or limits of the ratios of variable quantities. The view of one class of writers is that these distinguished men invented the calculus simultaneously and independently; and it is the fact that Leibnitz's system is unfolded from premises differing somewhat from those of Newton. Another class of writers hold that Newton is the real inventor, and that to Leibnitz no more can be conceded than that he was the first who, using the suggestions of Newton's genius, gave a systematic statement to the principle of the transcendental analysis, and invented its appropriate symbolic language. He had the doctrine of limits before him when he wrote, and did little more than unfold more fully the logic of the processes therein suggested, and exhibit them in algebraical forms. The calculus is only applicable where numbers have the continuous character—i.e., where they are or may be conceived as being variable. If two unknown quantities are connected by a single equation only, we clearly have the condition satisfied, as where y and x are connected by the equation

$$(1) \quad y = F(x),$$

where F is a sign denoting some *function* of x, as tan. x, cos. x, x^2, etc. This equality may be satisfied by innumerable values of y and x. One question which the calculus solves is, how does y vary when x varies? To solve it, and at the same time show how the doctrine of limits affects the definition of a differential, suppose x, y, and $x + Dx$, $y + Dy$, to be two pairs of values of the variables which satisfy the above equation; then

$$(2) \quad y = F(x), \quad \text{and (3)} \quad y + Dy = F(x + Dx).$$

From (2) and (3) we have, by subtraction,

$$(4) \quad Dy = F(x + Dx) - F(x);$$

whence we have the ratio

$$\frac{Dy}{Dx} = \frac{F(x + Dx) - F(x)}{Dx}.$$

This ratio will generally change in value as Dx and Dy diminish, till, as they both vanish, which they must do simultaneously, it assumes the form $\frac{0}{0}$. Taking this form, it ceases to have a determinate actual value, and it is necessary to resort to the method of limits to ascertain the value to which it was approaching as Dx and Dy approached zero. Let, then, dx and dy be any quantities whose ratio is equal to the limiting ratio of the increments Dx, Dy, so that

$$\frac{dy}{dx} = \text{limit } \frac{Dy}{Dx}$$

as Dx and Dy approach zero. Then dx and dy are the differentials of x and y. It may be observed that where x and y are connected as above they cannot vary independently of one another. In the case assumed, x has been taken as what is called the *independent* variable, the question being, how does y vary when x varies? If y were made the independent variable, it would be necessary to solve the equation $y = F(x)$, if possible, so as to express x in terms of y. The result would be an equation $x = \varphi(y)$. This being obtained, we should find $\frac{dx}{dy} = \text{limit } \frac{Dx}{Dy}$ as before. It will be seen that on this view differentials are defined merely by their ratio to one another. Their actual magnitude is perfectly arbitrary. This, however, does not render an equation involving differentials indeterminate, since their relative magnitude is definite, and since, from the nature of the definition, a differential cannot appear on one side of an equation without another connected with it appearing on the other.

The idea of a differential being once comprehended, the reader will be able to understand, in a general way, the main divisions of the calculus, which we shall now briefly delineate. So much is clear from what has been stated, that there must be two main divisions—one by which, the primary quantities being known, we may determine their differentials; and another by which, knowing the differentials, we may detect the primary quantities. These divisions constitute the Differential Calculus and Integral Calculus respectively.

1. *The Differential Calculus.*—Recurring to the formula already given, we know

$$\frac{dy}{dx} = \text{limit } \frac{Dy}{Dx} = \text{limit } \frac{F(x + Dx) - F(x)}{Dx}.$$

It is clear that, in the general case,

$$\frac{F(x + Dx) - F(x)}{Dx}$$

at the limit will still be some function of x. Calling it $F'(x)$, we have generally $\frac{dy}{dx} = F'(x)$. $F'(x)$ is called the first differential coefficient of y or $F(x)$. Being a function of x, it may be again differentiated. The result is written

$$\frac{d^2y}{dx^2} = F''(x),$$

$F''(x)$ being the second differential coefficient of y or $F(x)$; and again $F''(x)$ may be a function of x, and so capable of differentiation. Now it is the object of the differential calculus to show how to obtain the various differentials of those few simple functions of quantity which are recognized in analysis, whether they are presented singly or in any form of combination. Such functions are the sum, difference, product, and quotient of variables, and their powers and roots; exponentials, logarithms; and direct and inverse circular functions. The calculus so far is complete as we can differentiate any of those functions or any combination of them—whether the functions be explicit or implicit; and with equal ease we may differentiate them a second or any number of times. This calculus is capable of many interesting applications as to problems of maxima and minima, the tracing of curves, etc., which cannot here be particularly noticed.

2. *The Integral Calculus* deals with the inverse of the former problem. The former was: Given $F(x)$, to find $F'(x)$, $F''(x)$, and so on. The present is in the simplest case—viz., that of an explicit function: Given $\frac{dy}{dx} = F'(x)$, to find $F(x)$. The methods of the integral calculus, instead of being general, are little better than artifices suited to particular cases; no popular view can be given of these. In many cases integration is quite impossible. The explanation of *integration by parts*, by *approximation*, *definite integrals*, and *singular solutions*, is far beyond the scope of the present work. The reader is referred to any of the numerous text-books on the subject. The integral calculus has applications in almost every branch of mathematical and physical science. It is specially of use in determining the lengths of curved lines, the areas of curved surfaces, and the solid contents of regular solids of whatever form. The whole of the lunar and planetary theories may be described as an application of the integral calculus, especially of that branch of it which deals with the integration of differential equations. It is applied, too, in hydrostatics and hydrodynamics, and in the sciences of light, sound, and heat. In short, it is an instrument without which most of the leading triumphs in physical science could never have been achieved.

CALEBASSERIE.—A Belgian method of remelting iron in a sort of cupola furnace, with good results.

CALIBER—CALIBRE.—A technical name for the diameter of the bore of a fire-arm, whether a piece of ordnance or a small-arm. The ordnance from which solid shot are projected are usually denoted by the weight of each shot, as 24-pounder, 68-pounder, etc.; but mortars, and such guns as project shell or hollow shot, are more usually denoted by the caliber, such as 13-inch mortar, 10-inch shell-gun, etc. The caliber of the chief kinds of fire-arms will be noticed under the proper headings; but it may here be observed, generally, that the caliber of ordnance has been greatly increased within the last fifty years, partly by boring up old guns and partly by casting new.

Three important points are to be considered in determining the caliber of small-arms: 1st. The caliber should be as small as possible, to enable the soldier to carry the greatest number of cartridges; with the present caliber, the number of musket-cartridges is limited to 40; the total weight of which is about 3½ lbs. 2d. To diminish the amount of ammunition required to supply the wants of an army, and to prevent the confusion that is liable to arise from a variety of calibers, there should not be more than two for all arms of the same service, viz., one for the musket and one for the pistol. 3d. This point relates to the force and accuracy of the projectile. The introduction of elongated projectiles affords the means of increasing the accuracy and range of fire-arms, without increasing the weight of the projectile, simply by reducing the caliber, which diminishes the surface opposed to the air. Too great reduction of caliber, however, gives a very long and weak projectile; and besides, the effect of a projectile on an animate object depends not only on its penetration, but on the shock communicated by it to the nervous system, or upon the surface of contact. A projectile of very small caliber, having but little inertia, does not expand well into the grooves of the bore by the action of the powder; it is not, therefore, suited to the present method of loading at the muzzle.

The caliber of a piece of ordnance will be determined to a great extent by the purpose for which it is intended. It is necessary in the first place to decide the amount of powder in the charge, and how much expansive action is to be allowed for each pound of powder. The interior capacity of the bore being determined, the question then is to fix the relation between the diameter and length. The capacity increases with the square of the former and with the first power of the latter. The solution of this problem will be largely governed by considerations affecting the projectile. Assuming its weight to be fixed, its length will determine its diameter, so that a long shot implies a small bore. A lengthened projectile has both advantages and disadvantages: It meets with less atmospheric resistance and therefore loses less energy in its flight. It has greater penetration because it has a smaller hole to make. On the other hand, the lengthening of a shot increases its tendency to crush or break on striking. Used as a shell a long projectile contains less powder than a short one of equal weight and larger diameter, and is more liable to break by impact before explosion. Finally, a long projectile requires more rapid rotation to steady it, and this involves a greater expenditure of power in producing rotation. The question of caliber is therefore a very complex one, and it can only be settled by a compromise of conflicting considerations. The tendency, recently, has been toward a reduction in the caliber of guns for armor-piercing, this accompanied, however, by a proportional great increase of power. See *Cannon* and *Ordnance.*

CALIBER-COMPASS.—A form of calipers adapted to measure the sizes of bores. Another kind is used for measuring shot and shell. Also written *Caliper-compass.* See *Calipers* and *Shell-gauge.*

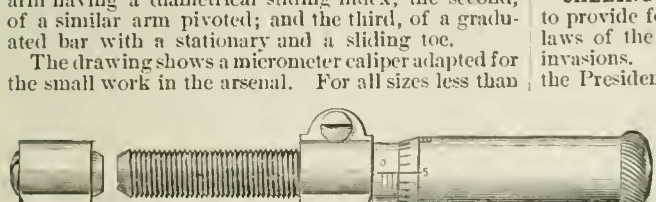
CALIBER-RULE.—A gunner's calipers, having two scales to determine the weight of a ball from its diameter, and conversely. Also written *Calibre-rule.*

CALICO BAGS.—A nature of bag used in England, in and attached to the interior of metal-lined and brass pentagon cases, for the preservation of loose powder in a damp climate when it cannot be preserved in ordinary barrels.

CALIGAE.—A kind of half-boots worn by the Roman soldiers. Such soldiers were sometimes called *Caligati.*

CALIPERS.—An instrument, jointed like a pair of dividers, but with arched legs, and adapted for taking the diameters of convex or concave bodies. It is said to have been invented by an artificer of Nuremberg in 1540. Numerous instruments of this class have been devised for different classes of work. Gunners' calipers are intended for measuring the bore or caliber of guns and projectiles. A scale like a sliding-rule has different sets of numbers engraved on it, to exhibit the corresponding diameters in inches and weights in pounds. The graduation is in accordance with the rule that with balls of the same metal the weights of the balls are as the cubes of their diameters. Calipers for inspecting hollow projectiles comprise those for measuring the thickness of metal at the bottom, at the sides, and at the fuse-hole reinforce. The first consists of a semicircular arm having a diametrical sliding index; the second, of a similar arm pivoted; and the third, of a graduated bar with a stationary and a sliding toe.

The drawing shows a micrometer caliper adapted for the small work in the arsenal. For all sizes less than one inch diameter this caliper will be found a reliable and convenient substitute for the vernier caliper, and will prove invaluable to armorers engaged on small and fine work. The binding and adjusting screws furnish the ready means of compensating for any wear resulting from use. Being small and light, it can be used as a pocket-tool. Although graduated to read to thousandths of an inch, half and quarter thousandths are readily obtained.



Micrometer Caliper.

A calipers designed especially for use in connection with the construction of tubes for 8-inch converted rifles consists of a curved steel plate and two attached measuring-points movable along the same right line. One of these points is fastened to a rod which slides in a socket attached to the steel plate. The rod is designed to occupy one of two positions, according to the size of the diameters to be measured, and is secured in either of these positions by a clamp-screw. At the other end of the curved plate the second measuring-point terminates a graduated limb, which, by means of a vernier and sliding microscope, can be read to .001 inch. This limb is fitted with a clamp and slow-motion screw, and has two sets of graduations, the one above the other; the lower read from about 9 inches to 14 inches, and the upper from about 12 inches to 17 inches. The lower graduations are used when the rod opposite is pushed in and clamped at its inner limit; the upper graduations, when the rod is pulled out and clamped at its outer limit. In making nice measurements, it is indispensable that the plane of the instrument be kept at right angles to the axis of the tube. This is secured by a wooden guide, which is held in rear of the instrument and is slid along the tube from one position to another. The base of the guide has the same curvature as the exterior of the tube, and is held firmly upright by two projecting arms extending in rear from either side, and which rest on the surface of the tube. By keeping the curved plate of the calipers in contact with the face of the guide, its true position is secured. See *Gauge* and *Inspection of Ordnance.*

CALIVER.—A hand gun or arquebuse—supposed by many to be the old name for the matchlock or carabine. It was so called because the bore was of a fixed size, in order that the common stock of bullets might fit every piece in a regiment. It was of greater caliber than the arquebuse, was lighter than the musket, and was fired without a rest.

CALK.—A projection from a shoe or clog which digs into the ice or frozen ground to prevent slipping. The word is also allied to the Anglo-Saxon word *calc*, a shoe; or the Latin *calcar*, a spur. In a horseshoe the calk consists of a downward projection from the heel, made by turning over the iron of the heel and sharpening it. The calk attached to a boot consists of a plate with spurs which project a little below the heel.

CALL.—A military musical term, meaning a signal on the drum, bugle, or trumpet for the assembling of troops, etc.

CALLING FORTH MILITIA.—Congress has power to provide for calling forth the militia to execute the laws of the Union, suppress insurrections, and repel invasions. By Act of Congress, February 28, 1795, the President is authorized to call forth the militia whenever—" 1. The United States shall be invaded or be in his judgment in imminent danger of invasion (from any foreign nation or Indian tribe); and to issue his orders for that purpose to such officer or officers of militia as he may think proper. 2. In case of an insurrection in any State against the government thereof, on application of the Legislature of such State, or of the Executive (when the Legislature cannot be convened). 3. Whenever the laws of the United States shall be opposed, or the execution thereof obstructed in any State, by combinations too powerful to be suppressed by the ordinary course of judicial proceedings, or by the powers vested in the Marshals; but whenever it may be necessary, in the judgment of the President, to *use* the military force hereby directed to be called forth in case of insurrection or obstruction to the laws, the President shall forthwith, by proclamation, command such insurgents to disperse, and retire peaceably to their respective abodes within a limited time." In cases where it is lawful for the President to call forth the militia, it shall be lawful for him to employ for the same purposes such part of the land or naval forces of the United States as shall be judged necessary, *having first observed all the prerequisites of the law in that respect.* See *Militia.*

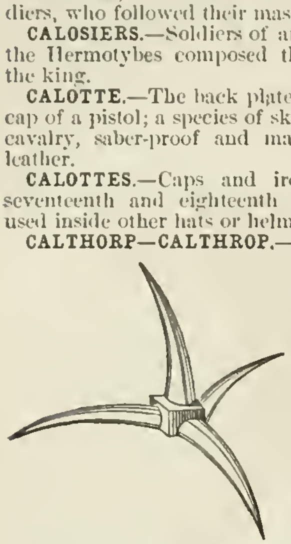
CALONES.—A term applied to menials of the Roman armies; also slaves belonging to the Roman soldiers, who followed their masters to the wars.

CALOSIERS.—Soldiers of ancient Egypt, who with the Hermotybes composed the particular guard of the king.

CALOTTE.—The back plate of a sword-handle; the cap of a pistol; a species of skull-cap worn by French cavalry, saber-proof and made of iron or dressed leather.

CALOTTES.—Caps and iron frameworks of the seventeenth and eighteenth centuries, which were used inside other hats or helmets.

CALTHORP—CALTHROP.—An obstacle in military warfare, consisting of a four-pronged piece of iron, each prong about four inches in length. When it is wished to check the approach of the enemy's cavalry over a plain, or of his besiegers in the ditch of a fortification, calthorps are sometimes thrown down; from their shape, one prong is sure to stand upright, and may work terrible mischief to the enemy's horses or men. Obstacles of other kinds having the same object in view, as small pickets, are sometimes used. Ordinary harrows turned upside down with the teeth upwards and the frames buried; planks with spikes driven into them, placed so as to have the points upwards, etc., may be used when practicable. Also written *Caltrop.* See *Crow's-feet.*



CALTHROP KNIFE.—A weapon about nine inches long, used in Saxony during the Seven Years' War. These knives were screwed on to beams of wood and placed under water in moats. The hole in the blade was intended to put a piece of stick through, so as to form a handle to screw the knife. Sometimes written *Calthorp Knife.*

CALUMET.—The *peace-pipe* of the North American Indians. It is a tobacco-pipe having a stem of reed about two feet and a half long, decorated with locks of women's hair and feathers, and a large bowl of polished marble. It plays an important part in the conclusion of treaties, of which, indeed, it may be described as the ratifier. After a treaty has been signed, the Indians fill the calumet with the best tobacco, and present it to the representatives of the party with whom they have been entering into alliance, themselves smoking out of it afterwards. The presentation of it to strangers is a mark of hospitality, and to refuse it would be considered an act of hostility. When a tribe wishes to go to war, messengers are sent to numerous other tribes asking for warriors for the expedition. The calumet (sacred and public property) goes with the mission. The whole subject is thoroughly discussed in council, and such tribes as grant the request accept the pipe and smoke.

CAM.—In gun-machinery, a curved plate or groove by which motion is communicated and controlled. The moving plate or groove is a *driver;* the rod, bar, or other thing moved is called the *follower.* The follower is held against the driver by its weight, or by a spring or other device. The radii of the driver determine by their length the motion of the follower, and the angles which they make with some one, chosen as a base of calculation, fix the time at which change of motion occurs. For example, it may be desired that the follower shall move upward, and then downward, with a uniform velocity. From the center of the driver any convenient number of radii may be drawn, dividing equally the 360° of angular space. On one of these radii we mark the distance from the center of the driver at which the point of the follower will stand when in its position nearest to that center. Upon the opposite radius, distant 180° from the first, the point is marked which gives the farthest position of the follower; the difference between these radii being divided into as many equal parts as we have made angular spaces in the 180°, we increase the length of each radius in succession, beginning with the shortest, by one of those parts, and we draw a curve connecting the ends of the radii so terminated. Of course the greater the number of parts chosen for the division of the angular space and of the difference of the first and last radii, the more accurately will the curve be drawn. The edge of the driving-plate being cut to this curve, the follower being made to press constantly against it, and the driver being turned with a uniform rotation, the follower will move through its limited space with an equable motion, because the radii of the driver increase by constant amounts, at constant intervals of time. If the curve is reversed, the second part being the symmetrical opposite of the first part, the follower will descend as uniformly as it rose. The cam thus drawn is one of frequent use, and is called the *heart-shaped* cam. To avoid friction the end of the follower often carries a roller which works against the surface of the cam; in this case the cam-surface is found by drawing a line parallel to that above described, at a constant distance equal to the radius of the roller. If we wish the follower to rest at any part of a cycle of motion, the radii for that time will be made equal, and the corresponding cam-surface will be a circular arc; the time will be such a part of that of a complete cycle as the angle between the radii of the ends of this arc is of 360°. The cam-plate has sometimes a groove cut upon its flat side, and the end of the follower runs in the groove. A spiral groove may be cut into the surface of a cylinder as in a screw; if a follower be inserted in this groove it will be driven forward as the cylinder turns; when the groove reaches the end of the cylinder, it may turn back, and cause the follower to return with the same motion, or if the pitch of the groove be made shorter or longer, the return of the follower will be changed accordingly. By a judicious construction and arrangement of cams, almost every variety of motion may be produced with the greatest precision as to time and amount. A cam-form which does not make a complete revolution, but after moving a short distance in one direction oscillates in the opposite direction, is called a *wiper.* A familiar example may be seen in the engine-room of a steamboat, in the rocking arms which raise and let fall the valve-rods. See the various descriptions of gun-machinery and engines throughout this work.

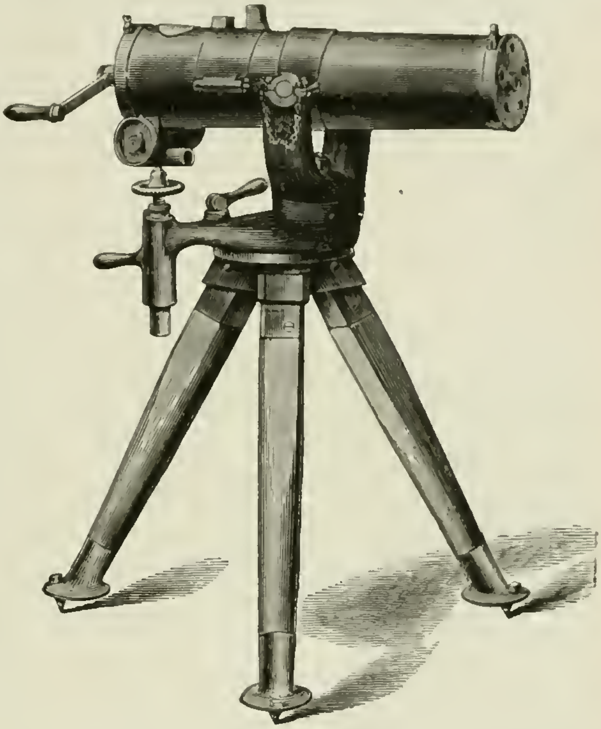
CAMAIL.—A neck-guard of chain, added to the bascinet. The word is either corrupted from *cap-mail* or owes its origin to the camail resembling the lower part of the capuchon, commonly worn by all classes, but which among the higher ranks was made of camel's hair, and therefore termed *camelin* by the French, from whence our word *camlet,* afterwards applied to an inferior stuff made in imitation of it.

CAMBRIDGE ASYLUM.—A charitable institution founded by the father of the present Duke of Cambridge to form a home for one widow of each British regiment. It is not yet completed, and is only capable of receiving, at present, about fifty widows.

CAMEL.—The camel is of great value as a pack-animal, and is admirably adapted for carrying long articles, such as scaling-ladders, pontons, etc. Of the two species, that known as the Arabian camel has only one hump on the back, whilst the Bactrian camel has two. Some confusion has arisen from the occasional employment of the name *dromedary* as a designation of the former species, it being, however, more properly limited to a particular variety of that species, more slender and graceful than the ordinary variety, and of much greater fleetness. Buffon's notion, that the hump is a badge of servitude, and the consequence of harsh treatment throughout many generations, is singularly at variance with what we know of its uses. The hump is a wonderful provision of nature, to adapt the animal to the endurance of long abstinence from food, or subsistence on very scanty supplies, to which it is often subjected in the desert, and without a capacity for which it would be comparatively of little value to man; and the wide deserts across which he journeys and transports his merchandise by its aid would be altogether unpassable. The hump is, in fact, a store of fat, from which the animal draws as the wants of its system require; and the Arab is very careful to see that the hump is in good condition before the commencement of a journey. After it has been much exhausted, three or four months of repose and abundant food are necessary to restore it. The backbone of the camel is as straight as that of other quadrupeds.—Another very interesting adaptation to the desert is to be noticed in the thick sole which protects the feet from the burning sand, and in callosities of similar use on the chest and on the joints of the legs, upon which the camel rests when it lies down to repose, or kneels, as it does for various purposes, and is taught to do that it may be loaded, or that its rider may mount upon its back.—The wedge-shaped cutting-teeth of the lower jaw are also particularly fitted for browsing on shrubby plants, such as the desert produces—the camel's thorn, tamarisk, etc., which form a large part of the food of the camel; the eyes are furnished with long eyelashes, to protect them from the glare and from the drifting sand; whilst the exclusion of the sand from the nostrils is also provided for by a power of closing their oblique openings at will. But most interesting of all is the provision made for the endurance of long drought, by the lining of the inside of the second stomach, or honeycomb-bag, and of a portion of the first stomach or paunch, with great masses of cells, in which water is stored up and long retained. This store of water is well known to the Arabs, who, when sore pressed by thirst, sometimes avail themselves of it by killing some of the camels of the caravan.

The Arabian camel carries twice the load of a mule. The Bactrian camel is sometimes loaded with 1000 or even 1500 lbs. weight, although not generally with so much, The East India Company had at one time a corps of camels, each mounted by two men, armed with musketoons. The use of the camel for the conveyance both of travelers and supplies has won it the name of the *ship of the desert.* A caravan sometimes contains 1000, sometimes even 4000 or 5000 camels. The supply of food carried with the caravan for the use of the camels is very scanty: a few beans, dates, carob-pods, or the like, are all that they receive after a long day's march, when there is no herbage on which they may browse. The pace of the loaded camel is steady and uniform, but slow: it proceeds, however, from day to day, accomplishing journeys of hundreds of miles at a rate of about 2½ miles per hour. Some of the slight dromedaries, however, can carry a rider more than 100 miles in a day. The motion of the camel is peculiar, jolting the rider in a manner extremely disagreeable to those who are unaccustomed to it; both the feet on the same side being successively raised, so that one side is thrown forward and then the other. Camels are particularly handy for fording rivers that are deep but not rapid; and where the bottom of the river is shifting sand, the passage of a number of camels over it renders it hard and firm. The average weight of the camel is about 1170 pounds. See *Pack-animals.*

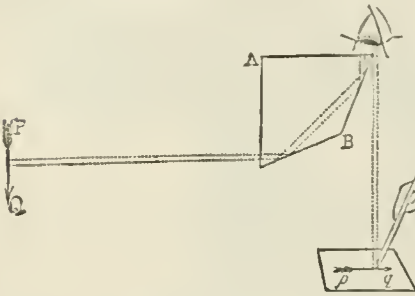
CAMEL-GUN.—When guns, like the Gatling gun, accompany expeditions in which it is impossible to use wheeled vehicles, they are carried on mules, horses, or camels. The guns designed for such use are called "camel-guns," and are lighter and shorter than the field-guns, but fire the musket-cartridge and have the musket range. Each gun with its carriage or tripod is carried on pack-saddles, and fifteen or twenty loaded feed-cases can be carried on the same saddles. The ammunition, with additional feed-cases, should be carried on the animals which march directly in rear of those which carry the gun and tripod. The drawing shows the new-model, musket-caliber, five-barrel Gatling gun, mounted on its tripod and ready for action. Its weight is 100 pounds, and fires 800 shots per minute. It is designed for transportation by mules or camels, or on the shoulders of men for short distances. The Gatling gun and its tripod are very conveniently transported, in the United States, in a packing-box invented by Mr. James Madigan. This box with the old-model Gatling gun is indeed requisite on account of the many projecting parts that would be exposed to the danger of being broken or damaged in timber, or clogged with leaves, twigs, etc., in the brush. The box is adapted to the shape and size of the gun and fixtures, and is so arranged internally that the motion of the pack-animal, when on the march, will not chafe or disarrange any of the parts of the gun or its appurtenances. The box is constructed and adapted for use with a pivoted pack-saddle, the upper arms of which have been arranged for this purpose, so as to bring the weight of the box as low as possible, and to support it firmly. See *Gatling Gun.*



New-model Five-barrel Gatling Gun.

CAMERA LUCIDA.—An optical instrument constructed of various forms, and for various purposes. Dr. Wollaston's instrument, intended to facilitate the perspective delineation of objects, consists of a small quadrilateral prism of glass, of which AB in the drawing is the perpendicular section, held in a brass frame, which is attached to an upright rod, having at its lower end a screw-clamp to fix it to the edge of a table. The prism being at the height of about a foot from the table, has its upper face horizontal. Two of its faces, as in the figure, are at a right angle at A;

the contiguous faces make respectively with them angles of 67½°; so that the remaining obtuse angle at B contains 135°. Rays coming from an object, PQ, and falling nearly perpendicularly on the first surface, enter the prism, and undergo total reflection at the contiguous surface; they then fall at the same angle on the next surface, and are totally reflected again; finally, they emerge nearly perpendicularly to the remaining surface. An eye, as in the figure, then receives the emergent pencil through one part of the pupil, so that an image, *pq*, of the object is seen projected upon a sheet of paper upon the table. The rays from the drawing-pencil passing the edge of the



prism, enter the other part of the pupil; and the pencil and image being seen together upon the paper, a sketch of the latter can be taken. There is, however, a practical difficulty—the image and the drawing-pencil are at distances sensibly different from the eye, and so cannot be seen together distinctly at the same time. To obviate this, a plate of metal, with a small aperture as an eye-hole, is placed at the edge under the eye, so that the rays through the prism, and those from the drawing-pencil, which both pass through the eye-hole, form only very small pencils. By this the difficulty is greatly diminished. It is still, however, difficult to use the instrument satisfactorily; and though many acquire great readiness in its use, others have never been able to attain the same facility. The instrument is remarkable for its small bulk and portability. A good one will pack in a box 8 inches by 2, and ½ inch deep. Besides this form of the instrument, which is the most common, there are others. Its simplest form is merely a piece of smooth glass fixed at an angle of 45° to the horizon. An image from a horizontal object falling on this glass will be perfectly reflected, and that in the vertical, so that the eye looking vertically down will see the image, and, owing to the transparency of the glass, the artist will be able to trace it out upon paper below. In this case, however, the image will be inverted.

The optigraph is an instrument for the same purpose, but of different construction.

CAMERA OBSCURA.—An instrument invented by Baptista Porta in the sixteenth century. It is known in its simplest form as a familiar toy, consisting of a rectangular box, furnished at one end with a lens whose focal length is equal to the length and depth of the box; at the opposite end of which a plane reflector is placed at an angle of 45°, which throws the image of any objects to which the lens may be directed on a piece of ground glass on the top of the box in a non-inverted position, so that they may be viewed or sketched from as in nature. The camera obscura being now an indispensable article in the practice of photography, has received a number of recent improvements, which make it rank as a scientific instrument. The principle, however, involved in the simplest and most refined forms is the same, and may be illustrated and made intelligible by the following experiment: Let a small hole be bored in a window-shutter, and the room be darkened. If, now, the beam of light entering the room by this hole be intercepted by a sheet of white paper, held at a short distance from the hole, an inverted image of objects without will be seen upon the paper. By placing a small convex lens over the hole, this image is rendered much more distinct, or *sharp*, in photographic language. Moreover, it will be found that at a certain distance from the hole the image attains a maximum degree of sharpness; and that if the paper be removed from this point to any position either nearer to the hole or further from it, the image becomes indistinct and confused. At the point of greatest distinctness the image is said to be *focused*. Such being the principle of the camera, it is evident that in practice the instrument may assume many forms, provided always that it consists of a darkened box or chamber having a hole at one end for the insertion of a lens, or combination of lenses, and at the other a screen, generally made of ground glass, on which to receive the image. The body of the instrument may be made of any opaque substance; the tube or tubes are generally formed of brass, and contain one or more lenses; there is the obscured or ground glass, upon which the image is thrown for the purpose of adjusting the focus; and the rack behind, by means of which, and the double sides of the camera, the body of the instrument may be lengthened or shortened till the image on the ground screen is accurately focused. This rack is most frequently placed upon the tubes carrying the lenses. The interior of the whole apparatus is blackened, to prevent reflection of the rays falling on their sides, and to impart greater distinctness to the picture.—The *camera-slide* is a thin, dark box, and is used for conveying a sensitive plate from the operating-room to the camera, and back again after exposure. It consists of a rectangular frame, made to fit exactly into the back of the camera when the focusing-screen is removed. At the back is a hinged door, by means of which the plate is introduced into the slide; and in front is a shutter, which is pulled up when the plate is to be exposed, and shut down after the time requisite for the action of the light upon the plate has expired. It must be constructed so that, when substituted for the focusing-screen, the surface of the prepared plate, which is intended to receive the image, shall correspond exactly in distance from the lens with the ground surface of the focusing-screen. The plate rests upon projections of silver wire in the corners of the slide; and the same slide may be used for plates of different sizes, by introducing into it thin frames of suitable dimensions also furnished with silver-wire corners.

CAMERON HIGHLANDERS.—The designation given to the 79th Regiment of Infantry in the British service, in consequence of the Corps having been raised by Allan Cameron of Erroch in 1793. Originally it consisted of 1000 men, but a second battalion was added in 1804. This gallant regiment, which wears the Highland garb, performed distinguished services in the Peninsula and at Waterloo, and in the chief warlike struggles of more recent times.

CAMERONIAN REGIMENT.—The 26th Regiment of Infantry in the British service, so called from having had its origin in a body of Cameronians during the Revolution of 1688. Taking advantage of their zeal and courage, the Convention which sat at Edinburgh induced a number of them to assist in the Revolution, which it was imagined by some was to re-establish the reign of the Covenants. They were induced to enlist on the understanding that the special object of the Corps was "to recover and establish the work of reformation in Scotland, in opposition to popery, prelacy, and arbitrary power, in all the branches and steps thereof, till the government in Church and State be brought to that luster and integrity which it had in the best of times." Thus was formed the celebrated Cameronian Regiment, with the youthful Lord Angus as Colonel, and William Cleland as Lieutenant-colonel and actual Commander. Under Cleland, not yet in his thirtieth year, the Regiment was sent northwards to quell the insurrection, after the fall of Viscount Dundee. Surrounded by from 4000 to 5000 Highlanders, the Cameronians, only 800 strong, gallantly defended themselves during a whole day in Dunkeld, August 21, 1689. In this terrific struggle the brave Cleland was killed. Considering the issue of the Revolution, they had been entrapped into military service, and their employment on foreign service afterwards greatly scandalized the Cameronian sect. The Regiment has ever done credit to its origin, being distinguished alike for gallantry and for good conduct.

CAMION.—A substantial dray used for transporting heavy ordnance and ordnance stores.

CAMISADO.—1. A shirt formerly worn by soldiers over their uniform, in order to be able to recognize one another in the darkness, in a night-attack. 2. An attack by surprise at night, or at break of day, when the enemy is supposed to be in bed, by soldiers wearing the *camisado*.

CAMOUFLET.—A small mine used to suffocate the enemy's miners without producing an external explosion. It is sometimes formed in the wall or side of a gallery, in order to blow in the earth and to cut off the retreat of the miners. The charge is usually about ten pounds of powder—sufficient to compress the earth all around it without disturbing the surface of the ground.

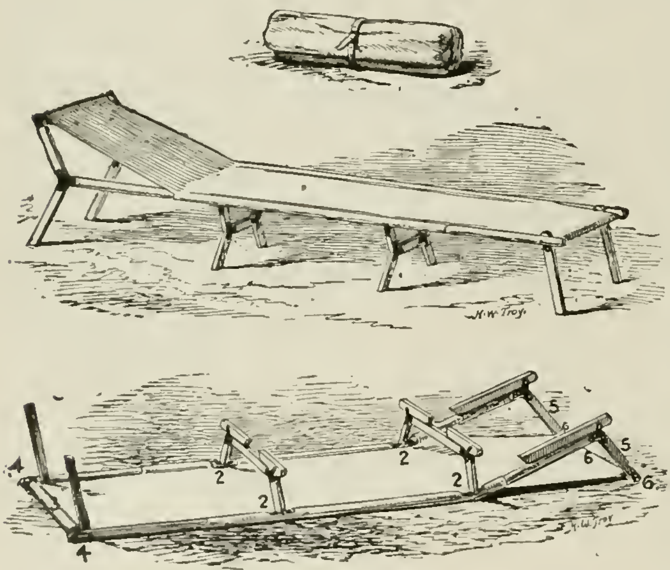
CAMP.—The signification of this word in English is rather that which belonged to the Latin *castrum*, an encampment, or *castra*, a collection of tents, huts, and other structures, for the accommodation and protection of troops, than that which its etymology would more directly indicate. The regular system of encampment ultimately adopted by the Romans was forced upon them by degrees. The most complete account of it is furnished to us by Polybius. When a Roman army was about to encamp, a Tribune and several Centurions were sent on before, to select a suitable site for the purpose. As soon as the locality was determined on, they chose the spot for the Prætorium or General's tent, and marked it with a white flag. Around the Prætorium, as a sort of center or heart to the whole system, the rest of the camp was laid out. It was generally placed on an elevated position, in order that the General might have the rest of the encampment under his eye, and be able to transmit his orders with greater facility. Polybius himself tells us that the best conception which can be formed of a Roman camp of the more permanent kind is by regarding it as a military town, resembling in many respects no doubt that which has recently grown up at Aldershott. The streets were broader than those usually to be found in towns, the wider ones measuring 100 and the narrower 50 feet; and the *Forum*, as its name indicates, was a sort of public market-place. A space of 200 feet was left vacant all round between the tents and the ramparts, partly to afford space for the arrangements of the army, and for stowing away any booty that might be captured, but chiefly to protect the soldiers' huts from incendiary attempts from without. In form the Roman camp was square, except in the case in which it was intended to embrace within its ramparts four legions, or two consular armies, when it became an oblong rectangle. The camp was surrounded by a fosse or trench, which was generally 9 feet deep and 12 broad. On the top of the rampart, which was of earth, there were stakes. The labor of constructing the rampart and the fosse was divided between the allies and the Roman legions, the former making the sides along which they were stationed, and the legions the rest. The task of superintending the construction of the camp amongst the Romans was intrusted to the Tribunes; amongst the allies, to the Prefects. Before the arrival of the troops, the different parts of the camp were so distinctly marked out and measured off that they at once proceeded to their respective stations, as if they had entered a well-known city and were marching to their quarters. The discipline of the camp was of the strictest kind. The Tribunes administered an oath against theft both to freemen and slaves, and two maniples were chosen to keep the *via principalis*, which was a place of general resort, clean and in good repair. The other occupations connected with the camp, too numerous to be mentioned here, were portioned out in like manner; and the superintendence of the whole was intrusted to two Tribunes chosen by lot from each legion, and appointed to serve for two months. The Prefects of the allies possessed a similar authority, which, however, seems to have been limited to their own troops. Every morning at daybreak the Centurions and horsemen presented themselves to the Tribunes, and these, in their turn, received their orders from the Consul. The watchword for the night, marked on a four-cornered piece of wood, was given out with much formality. The night was divided into four watches, each of three hours' length; and there was a curious arrangement for ascertaining that guard was kept with vigilance. The soldiers of the watch companies received from the Tribune a number of small tablets, with certain marks upon them, and these tablets were collected during the night by the horsemen whose duty it was to visit the posts, from such of the guards as they found on duty. Where these inspectors found the guards asleep or absent, they called upon the bystanders to witness the fact, and then passed on to the next. In the morning the inspectors appeared before the Tribunes, and gave up the tablets they had received, when the guards whose tablets were not produced were required to account for them. A regular scale of rewards and punishments was established in the camp. In comparing the encampments of the Romans with those of his own countrymen, Polybius tells us that the Greeks trusted mainly to a judicious selection of their ground, and regarded the natural advantages which they thus secured as supplying in a great measure the place of artificial means of defense. The Greeks, consequently, had no regular form of camp, and no fixed places were assigned to the different divisions of the army. When the practice of drawing up the army according to cohorts, introduced by Marius and Cæsar, was adopted, the internal arrangements of the camp experienced a corresponding change. Latterly even the square form was abandoned, and the camp was made to suit the nature of the ground. It was always held to be of importance, however, that the camp occupied a defensible position; that it could not be overlooked; and that it had a command of water. When stationary camps (*castra stativa*) came into more general use, we hear of several parts which are not mentioned by Polybius; for example, the infirmary (*valetudinarium*), the farriery (*veterinarium*), the forge (*fabrica*), etc.: and as a great variety of troops then came to be employed, they must, of course, have had new stations appointed to them in the camp. Many of the stationary camps ultimately became towns, and to this is ascribed the origin of most of the towns in England the names of which end in *cester* or *chester*. Among the most perfect of those which retained the form of the simple encampment is that at Ardoch in Strathearn, Perthshire, in the grass-covered mounds and ridges of which most of the divisions of the camp have been distinctly traced by antiquaries. It is believed that during the Middle Ages the plan adopted by the Romans in their camps was more or less adhered to, seeing that the weapons employed, which mainly determined the character of the troops, were nearly the same. In Britain, before the arrival of the Romans, and also during the Saxon and Danish periods, the camps, usually circular in form, appear to have been somewhat rude in character, with the cavalry grouped round the standard in the center, and the infantry placed near the front. The principles of castrametation, or camp-formation, underwent much change after the invention of gunpowder, owing to the necessity for defending the camp from artillery. See *Bivouac Cantonments, Castrametation Encampment*, and *Field-service*.

CAMPAIGN.—A connected series of military operations, forming a distinct stage or step in a war. Under the old system of warfare, when armies kept the field only during the summer months, a campaign was understood to include all that was done by an army from the time it took the field till it went again into winter-quarters. Now that winter is no longer allowed to arrest military operations, it is more difficult to say where one campaign ends and another begins. Some writers make a campaign include all the steps taken to accomplish some one immediate object.

CAMPAIGNER.—One who has served in an army through several campaigns; an old soldier or veteran.

CAMP AND GARRISON EQUIPAGE.—All the tents, fittings, utensils, etc., carried with an army, applicable to the domestic rather than to the warlike wants of the soldier. The allowance of camp and garrison equipage to United States troops is prescribed in General Orders from the War Department.

CAMP-BEDSTEAD.—A bedstead made to fold up within a narrow space, so as to be easily transported, and suitable for use in war. The drawing shows such an arrangement, which was patented by Mr. John Boyle, in France and the United States, not long since. It weighs complete about 9½ pounds, and when folded it occupies a space less than 7 inches square by 25 inches in length. After being properly set it is exceedingly strong and durable, and cannot be broken except by violent usage. It can be set anywhere and will remain stationary on a boarded



Boyle Camp-bedstead.

floor or a plowed field. To set it, spread the canvas out face-side down; open the four arms which have iron caps at the ends (the short ones), and insert the ends having the caps into sockets which are used in folding as hinges, the same being about twenty inches distant on each side from the head and foot respectively; put the thinner stick (the one with pins in the end—not screws) through the hem or tabline; insert the pins in the holes, severally, behind the legs at the foot; open the arms which give elevation to the head; run the heavy round stick (the same having a round-headed screw at each end) through the hem. Insert these pins or screws in the slots or grooves; last of all, open the legs, commencing with the center ones; turn the bedstead over right-side up, and it is then ready for using, without mattress, bed, or padding of any description.

CAMP-CHAIR.—A form of folding chair adapted to be carried by a pedestrian, or packed away in the ambulance or wagon when on the march. See *Camp-stool.*

Camp-chair.

CAMP-COLORS.—In the United States army, the camp-colors are the stars and stripes, as described for the garrison-flags, printed upon bunting, 18 by 20 inches, on a pole of ash, 8 feet long and 1¼ inch in diameter; the butt end of the pole is armed with a pointed iron ferrule, screwed on with four wooden screws. See *Colors.*

CAMPESTRE.—A kind of girdle or apron worn by the Roman soldiers around their waists at certain exercises where the rest of their bodies remained naked.

CAMP-FOLLOWERS.—The sutlers and dealers in small wares who follow an army. In India, owing to the peculiar habits and customs of the Hindus, and the large number of servants retained by English officers, the camp-followers are in immense number, comprising the servants, sutlers, cantiniers, hostlers, water-carriers, snake-charmers, dancers, conjurers, and women. In February, 1839, when a Bengal army of 15,000 men left Shikarpoor for Afghanistan, it was accompanied by no fewer than 85,000 camp-followers; the Commander took with him six weeks' food for the whole 100,000. All English Commanders in India find this regulation a very burdensome one. Even in the European armies, however, camp-followers are regarded as necessary; they are under the control of the Commanding Officer, and are subject to the Articles of War—not, however, in cantonments, only in the field. French armies are accompanied by women much more largely than English.

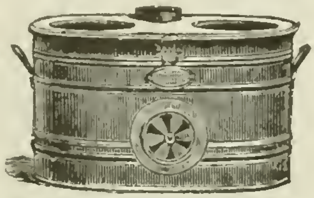
CAMP-GUARD.—A guard consisting of one or two rows of sentinels placed around a camp and relieved at regular intervals. The composition and posts of the camp-guard will depend upon the character of the ground and the degree of danger apprehended.

CAMPHENE.—The name applied to a variety of spirit of turpentine obtained from the *Pinus australis* of the Southern States of America, and rather extensively sold and used in Britain for burning in out-of-door lamps. It is very volatile, and burns very freely, giving off a pure white brilliant light; and when the vapor diffuses itself through air, and is set fire to, it forms a dangerous and violently explosive mixture.

CAMPHOR.—A solid essential oil which is found in many plants, and may be separated from many essential oils. It particularly abounds in certain species of the natural order *Lauraceæ.* Almost all the camphor of commerce is the produce of the camphor-laurel, (*Camphora officinarum,* formerly known as *Laurus camphora*), a native of China, Japan, Formosa, and Cochin-China, and which has been introduced into Java and the West Indies. The camphor-laurel is a tree of considerable height, much branched, with lanceolate, evergreen leaves on short stalks, and small yellowish-white flowers in axillary and terminal panicles. The fruit is in size and appearance not unlike an imperfectly ripened black currant. Every part of the tree, but especially the flower, smells strongly of camphor. The wood is light and durable, not liable to be injured by insects, and much valued for ordnance work. In the extraction of camphor from the camphor-laurel, the wood of the stem and branches


CANADA
SCALE OF MILES
0 50 100
Railroads
RUPERTS LAND
ONTARIO
QUEBEC
NEW BRUNSWICK
NOVA SCOTIA
PRINCE EDWARD ISL'D
CAPE BRETON ISLAND
ANTICOSTI
GULF OF ST LAWRENCE
ATLANTIC OCEAN
LAKE SUPERIOR
LAKE HURON
GEORGIAN BAY
LAKE ONTARIO
LAKE ERIE
MICHIGAN
NEW YORK
PENNSYLVANIA
OHIO
MAINE
UNITED STATES
CONNECTICUT
New York
Philadelphia
Boston
Toronto
Ottawa
Montreal
Quebec
Halifax
Fredericton
St. John
Hamilton
Kingston
Buffalo
Cleveland
Albany
Portland
Bangor
Augusta
NEWFOUNDLAND
On a reduced Scale
St. John's
Longitude West of Greenwich
Reference to Smaller Counties in Ontario or Upper Canada
1 Essex
2 Bothwell
3 Lambton
4 Middlesex
5 Elgin
6 Norfolk
7 Oxford
8 Perth
9 Waterloo
10 Brant
11 Haldimand
12 Welland
13 Monck
14 Wentworth
15 Halton
16 Peel
17 Cardwell
18 Durham
19 Northumberland
20 Pr. Edward
21 Lennox
22 Frontenac
23 Grenville
24 Dundas
25 Russell
26 Stormont
27 Prescott
28 Glengary
Reference to Smaller Counties in Quebec or Lower Canada
1 Argenteuil
2 Two Mountains
3 Terrebonne
4 L'Assomption
5 Vaudreuil
6 Soulange
7 Huntingdon
8 Beauharnois
9 Chateauguay
10 Napierville
11 La Prairie
12 Chambly
13 Vercheres
14 Richelieu
15 S. Hyacinthe
16 Rouville
17 Iberville
18 St. John
19 Missisquoi
20 Brome
21 Shefford
22 Bagot
23 Drummond
24 Yamaska
25 Nicolet
26 Arthabasca
27 Wolfe
28 Richmond.
29 Sherbrooke
30 Stanstead
31 Compton
32 Beauce
33 Megantic
34 Lotbiniere
35 Levi
36 Dorchester
37 Bellechasse
38 Montmagny

is chopped up into fragments, and introduced into a still with water and heat applied, when the steam generated carries off the camphor in vapor. These vapors rise, and in passing through rice-straw, with which the head of the still is filled, the camphor solidifies, and is deposited round the straw in minute grains or particles, somewhat about the size of raw sugar or coarse sand. These grains of impure camphor are detached, and being introduced into a large globular glass vessel in quantities of about 10 lbs., are reheated, when first the water rises in steam, and is allowed to escape at a small aperture; and thereafter, this aperture being closed, the camphor sublimes and resolidifies in the interior upper part of the flask as a semi-transparent cake, leaving all the impurities



Camp-stove.

behind. The flasks are then cooled and broken by throwing cold water on them, and the camphor taken out and sent into market. The glass globes employed are called by an Italian name, *bomboloes*, the sublimation of camphor having been first practiced in Venice. —Camphor was unknown to the Greeks and Romans, and was first brought to Europe by the Arabs. It is a white tough solid, slightly lighter than water, and floats thereon. It is very sparingly soluble in water, but freely soluble in alcohol, ether, acetic acid, and the essential oils. It fuses at 347°, and boils at 399 , and when set fire to is very inflammable, and burns with a white smoky flame. Thrown upon water, it floats, and may be set fire to when the currents generated alike from the solution in water and the irregular burning of the pieces cause a curious rotatory motion. It has a peculiar hot aromatic taste, and an agreeable characteristic odor. In consequence of its combustible powers it is much used in fire-works.

CAMPIDOCTORES.—Officers to whom was assigned the duty of drilling the Roman soldiery.

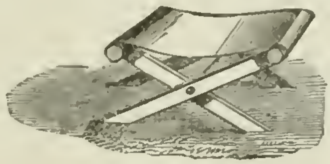
CAMP-KIT.—A box, with its contents, for containing soldiers' cooking and mess utensils, such as the camp-kettles, plates, etc.

CAMP-MILL.—A mill adapted for the use of an army, to grind grain on the march or in camp. It is carried on a wagon or running-gear, and is sometimes driven by the wheels in traveling, sometimes by a sweep operated by horses or men after the wheels are anchored or sunk in the ground. The first portable mill thus adapted to its own carriage appears to have been invented by Pompeo Targone, Engineer to the Marquis Ambrose Spinola, about the end of the sixteenth century.

CAMP OF INSTRUCTION.—An encampment of troops in the field to habituate them to the duties and fatigues of war. They may be either temporary or permanent. Of the latter description are the camps at Aldershott, England, and the Curragh of Kildare, Ireland.

CAMPOOS.—Regiments of Infantry in the service of the Mahratta Confederates.

CAMP-STOOL.—A chair whose frame folds up into a small compass for convenience of packing or carriage. Camp-stools were known in ancient Egypt, and were constructed in a manner similar to ours.



Camp-stool.

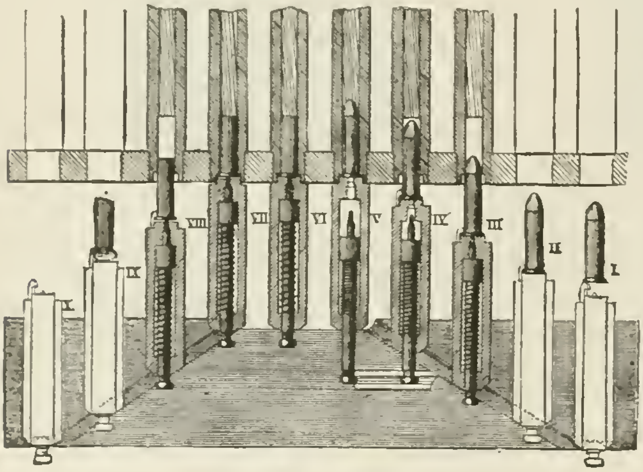
They frequently occur in the paintings, and some have been preserved until our time. One found at Sakkarah is in the Abbott Collection, New York. See *Camp-chair*.

CAMP-STOVE.—A light sheet-iron stove, specially arranged with a view to portability, and adapted for heating a tent or hut, and for cooking purposes. The drawing shows such a stove, capable of cooking for a mess of six or eight persons. When packed for transportation, all the apparatus is inside, and the total weight is 22 pounds. The ware is so constructed that it nests and packs in the oven, which has a capacity sufficient for roasting 20 pounds of beef. The oven packs inside the stove, and leaves sufficient room for packing the plates, knives, forks, spoons, and drinking-cups. This stove boils, bakes, or broils; and when fuel is scarce its excellence is very apparent, as it requires so little. In cold weather it may be placed inside the tent, where it is a great luxury and saves much trouble.

CAMPUS.—In ancient Rome, a vacant space in or near a city, for public combats, etc. There were eight around Rome, of which the Campus Martius (Camp of Mars) was the most important. It was outside the walls, occupying the level space between the Quirinal, Pincian, and Capitoline Hills. In this met the *comitia centuriata* and the *comitia tributa;* and in it was the Public Hall for the use of the Magistrates and Foreign Ambassadors, who were not permitted to enter the city. In later times it became a pleasure-ground, with shaded walks, gardens, baths, theaters, and a race-course. Julius Cæsar built within it the marble halls for the comitia; Agrippa, the baths and the Pantheon; Augustus, his own mausoleum; and Statilius Taurus, the first stone amphitheater. Later emperors crowded this particular campus with public buildings and private residences. Under Aurelian it was taken in as a part of the city. The district in which the old campus was situated is now called Campo Marzo. Another ancient campus was the Sceleratus, the Polluted Field, where vestals who had been untrue to their vows of chastity were buried alive. The drill-grounds around modern colleges often bear the name of *campus*.

CAM-RING.—A portion of the firing mechanism in certain machine-guns. In the Gatling gun, within the cylindrical breech-case attached to the frame, a heavy ring not quite the length of the lock-cylinder is fastened to the case and diaphragm, which nearly fills the space between the inside of the case and the cylinder. Portions of the inside of this ring are so cut away as to leave a truncated, wedge-shaped, annular or spiral *cam* projecting from the inner surface of the ring, having two helicoidal edges inclined to each other, and united by a short, flat plane. Against these edges the rear ends of the locks or breech-plugs continually bear, there being room enough for the locks to lie loosely within the parts of the ring which are cut away. The apex of the wedge-shaped cam points to the barrels. Each lock is held back against the cam by a lug or horn projecting laterally from the end of the lock and entering a groove formed at the base of the cam, in the thin part of the ring.

The drawing shows the *cam-ring* as it would appear if cut open and spread out flat, the lower lines being the development of the edges of the helicoidal cam-surfaces. The ten locks are shown in their relative positions abutting against the cam-surfaces, six of them being shown in section. It will be seen that the points of the firing-pins, or lock-hammers, protrude beyond the front of the locks, while the spindles project from the rear, where they are fashioned into knobs by which the hammers are drawn backward and cocked while passing through the groove in the *rib*. It will be observed that the distance of the apex of the cam from the ends of the barrels is such that the breech-plugs or locks exactly fill the space, so that each plug there forms an abutment which closes the breech of its barrel and abuts against the apex of the cam, which serves to resist the recoil of the plug when the charge is fired.



Cam-ring of Gatling Gun.

The locks are guided in grooves formed in the *lock-cylinder*, and therefore cannot deviate from their alignment with the barrels. The cartridges will, as the carrier-block channels come successively under the hopper, drop into the channels in front of the locks, and be kept in place by the hopper-plate. The revolution of the lock-cylinder carries the locks around with it, and causes them to receive a longitudinal reciprocal motion by their ends sliding along the inclined surfaces of the stationary cam. Each lock, then, one after the other, is pushed forward toward its barrel. As the revolution of the parts keeps the locks in contact with the advancing side of the cam, each lock in succession closes its barrel, and its longitudinal motion ceases, while it passes the flat surface of the cam, and then each slides backward from its barrel when constrained to move along the retreating side of the cam by the corresponding cam-groove; and so on, each lock repeating these movements at each successive revolution of the shaft. The position of the cam relatively to the cartridge-hopper is such that each lock is drawn backward to its full extent when it passes the hopper, so that the cartridges may fall into the carrier in front of the locks. The explosion of each cartridge takes place as its proper lock passes over the flat apex of the cam which resists the recoil. The hammer is cocked by the knob or head at its rear end coming into contact with a flat *rib* located inside of the cam. This rib restrains the hammer from moving forward, while the forward movement of the body of the lock continues; the spiral mainspring is compressed until the revolution carries the hammer-knob beyond the end of the cocking-rib, when the hammer will spring forward and strike with its point the center of the cartridge-head, and explode the charge. The point in the revolution at which the barrels are discharged is below and at one side of the axis. Each breech-plug or lock carries a hooked *extractor* which snaps over and engages the cartridge-flange when the plug is pushed forward, but which, when the plug retreats, withdraws and ejects the empty case. The drawing shows the ten locks, each in a different part of its cycle of action. At I the cartridge has just dropped in front of the lock; at II it has been pushed forward somewhat; at III the point of the cartridge has entered the barrel; at IV it is pushed nearly home, and the head of the hammer is retained by the cocking-rib, the mainspring being partly compressed. At V the lock has reached the flat part of the cam, the cartridge is pushed quite home, and the mainspring has been fully compressed by the retention of the hammer by the cocking-rib, the end of which is just reached by the hammer, which is about being released. At VI the hammer having been released has sprung forward and exploded the cartridge, the end of the lock or breech-plug being firmly braced against the flat surface of the cam. At VII the lock has commenced to retreat, and at VIII it has partially withdrawn the empty cartridge-shell from the barrel. At IX it has completely extracted the shell, which is falling away from the gun. At X the lock is fully drawn back, and is about to pass again into its first position. See *Gatling Gun*.

CANDITEER.—In fortification, a protection for miners, consisting of brushwood, etc.

CANDJIAR.—A kind of crooked Turkish saber Also written *Canjar*.

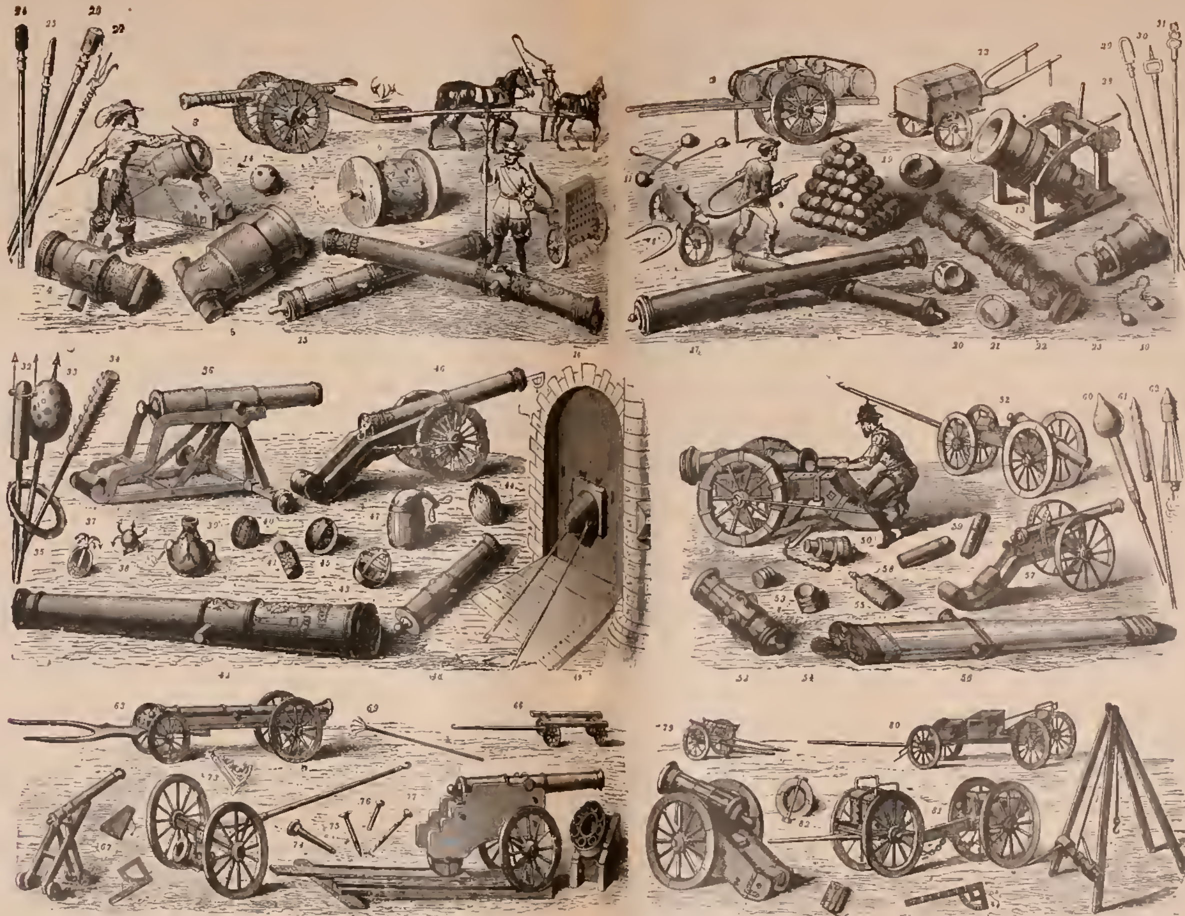
CANDLE-BOMBS. — Pasteboard shells filled with pyrotechnic compositions, which make a brilliant display on explosion. They are used for signaling, and are made up with a powder-charge attached to one side; a strand of quickmatch leads to the charge when placed in the mortar. The mortars used are very light, being simply hollow cylinders of stout paper, sole-leather, or wood. They are made thus light for ease of transportation.

CANDYS.—A loose gown, worn by the Medes and Persians over their other garments. It was made of woolen cloth, which was either purple or of some other brilliant color, and had wide sleeves. In the sculptures at Persepolis nearly all the personages are represented as so attired. A gown of a very similar kind is still worn by Arabians, Turks, and other Orientals.

CANE GUN.—A weapon comprising a gun-barrel with its discharging devices arranged within the shaft of a cane so as to present the appearance of an ordinary walking-stick. See *Air-gun*.

CAN-HOOK.—A device for slinging casks in hoisting. The ends of a piece of rope are reeved through the eyes of two flat hooks and stopped. The tackle is hooked to the middle of the bight.

CANISTER-SHOT.—A canister-shot is a metallic cylinder about one caliber in length, filled with balls and closed at both ends with wooden or metal disks. They are supplied for all guns. For 8-inch canister, and all those of less caliber, the envelope is made of tin, while canister for the larger calibers have an envelope of iron. The bottom of 15-inch canister is made of two thicknesses of 1-inch hard wood, crossing each other, and put together with



CANNON, etc. *Antique:* 1. French six-pound false culverin (1550). 2. French ammunition cart (1560). 3. French twenty-pound mortar. 4. German eighteen-pound mortar, called "Elephant" (1565). 5. German twenty-five-pound mortar (1800). 6. Storming keg (1680). 7. German fire-shield (1620). 8. German chariot of battle (1620). 9. Pile of balls. 10, 11. Chain and stem-shot. 12. Danish cartridge carriage (1720). 13. German twenty-pound mortar, with carriage. 14. Fire bomb. 15. German sectional field-piece (1680). 16. German twenty-pound culverin (1550). 17. French culverin (1550). 18. German falconet (1730). 19. Concentric bomb. 20. Excentric bomb. 21. Explosive fire-bomb. 22. Italian Bombarde (1500). 23. Italian mortar (1500). 24. Sponge. 25. Loading-shovel. 26. Rammer. 27. Fuse. 28. Spike. 29. Swipe. 30. Charge drawer. 31. Ball extractor. 32. Double-barbed spear. 33. Storming spear. 34. Storming club. 35. Storming wreath. 36. Danish iron gun-carriage for forts (1713). 37. Hot-shot, with anchor. 38. Anchor ball. 39. Fire-jug. 40. Fire-ball. 41. Gun-cartridge. 42. Forty-pound cannon of Charles V. 43. Fire-cross. 44. Fire-ball. 45. Explosive-ball. 46. German twelve pound field-piece. 47. Powder-barrel. 48. Prussian twelve-pound field-piece (1812). 49. Petard. 50. German breech-loader (1550). 51. French field-piece (1750). 52. Prussian ten-pound howitzer (1812). 53. Cartridge. 54. Wad. 55. Bag-cartridge. 56. German cannon, with oval lumen (1680). 57. Danish three-pound field-piece, with cast-iron carriage (1713). 58. Ball-cartridge. 59. Shot-cartridge. 60. Prussian petard rocket. 61. Rocket with side-staff. 62. Rocket without staff. 63. Gun-carriage, with heavy ordinance. 64. French mountain-piece (1680). 65. Drag. 66. Block-chassis. 67, 68, 73, 83. Quadrants. 69. Probe. 70. High-chassis, with twenty-four pound cannon. 71. French mortar, with side-chambers (1680). 72. Prussian twenty-five-pound howitzer. 74. Fuses. 75 to 77. Tin-fuses. 78. French brake (1808). 79. Trangree cart. 80. Field-forge. 81. English seven-pound howitzer (1800). 82. Wooden mold for fire-balls. 83. Derrick (1720).

wrought-iron nails clinched. A spindle, with a wrought-iron handle passing through the center of the canister, is riveted on the bottom through a square plate. All other canister have bottom-heads of one thickness of hard wood. Top-heads are all made of white pine. The case is notched, turned over the heads, and tacked down. The balls for all canister are 1.3 inch diameter, and the number used varies with the caliber. To give more solidity to the mass, and prevent the balls from crowding upon each other when the piece is fired, the interstices are closely packed with sawdust. See *Case-shot*, *Projectiles*, *Rifle-canister*, and *Siege and Garrison Ammunition*.

CANKER.—A disease of the foot of the horse, believed by Gerlach, of Berlin, to be truly cancerous, is observed in two different forms: in the acute stage, when the malady is chiefly local; and in the chronic stage, when the constitution suffers, and all local remedies fail to restore a healthy function of the structures of the foot.

Symptoms.—It usually commences by discharge from the heels, or the cleft of the frog of the horse's foot. The horn becomes soft and disintegrated, the vascular structures beneath become inflamed, and the pain which the animal endures is intolerable. It is therefore very lame on one, two, or all feet, according to the number affected. Though there is no constitutional fever, the horse becomes emaciated and unfit for work. During wet weather, and on damp soil, the symptoms increase in severity. The sore structures bleed on the least touch, and considerable fungoid granulations, commonly called *proud flesh*, form rapidly.

Causes.—This disease is occasionally hereditary, and it is most frequently seen in low-bred draught- or coach-horses. Dirt, cold, and wet favor the production of the disease, and there is always a tendency to relapse when once an animal has been affected.

Treatment.—Pare away detached portions of horn, and, in mild cases, sprinkle powdered acetate of copper over the sore; apply over this pledgets of tow, fixed over the foot by strips of iron or wood passed between shoe and foot. In severe cases tar and nitric acid, creosote and turpentine, chloride-of-zinc paste, and other active caustics have to be used for a time with the regular employment of pressure on the diseased surface. The animal requires to be treated constitutionally by periodical purgatives and alteratives. Good food, fresh air, and exercise often aid much in the treatment of the disease.

CANNELURE.—A cut in the lead round the projectile near the base in order to receive a lubricant or any lead that may be drawn down during the passage of the projectile through the bore.

CANNON.—A general name for large pieces of ordnance or artillery, as distinguished from those pieces which can be held in the hand while being fired. No military weapon in use before the invention of gunpowder can fairly come under this designation; they were more generally of the kinds described under BALISTA. At what exact date cannon were first used is not known; but cannon, called "crakys of war," were employed by Edward III. against the Scots in 1327, by the French at the siege of Puy Guillaume in 1338, and by Edward III. at Crecy, and at Calais in 1346. The first cannon or *bombards* were clumsy, wider at the mouth than at the chamber, and made of iron bars hooped together with iron rings. The balls fired from them were first made of stone, afterwards superseded by iron. In the fifteenth century various kinds were known by the names of cannon, bombards, culverins, serpentines, etc. Bombards of great length and power were employed by Louis XI. during his Flemish campaign in 1477, some with stone balls, some with iron. About this time cannon began to be made by casting instead of with hooped bars; and bronze or brass as a material began to be used as well as iron. The cannon of the sixteenth century were generally smaller, but better finished, than those of the fifteenth. The largest cannon made in the seventeenth century, so far as is known, was the Bejapoor cast-iron gun, "Malick é Meidan," or "Lord of the Plain," made either by Aurungzebe or by the Mahrattas; it was 14 feet long, 28 inches bore, and required a ball of 1600 lbs. weight. From the time of the great European wars in that century, cannon have undergone vast improvements, as well as the science and art of artillery necessary for their management.

Cast-iron cannon may generally be divided into five principal parts, viz., *Breech*, *Cylinder*, *Curve*, *Chase*, and *Muzzle*. The *Breech* is the mass of solid metal in rear of the bottom of the bore: the thickness is usually somewhat greater than the greatest thickness of metal in the cylinder. The *Cylinder* is that portion between the base-ring and trunnions, including the seat of charge and the point where the greatest strain is exerted upon the gun. The *Curve* is the portion connecting the cylinder with the chase. It is made somewhat thicker than necessary to resist the pressure of the powder, in order to serve as a proper point of support for the trunnions, and to compensate for certain defects of metal liable to occur in the vicinity of the trunnions of all cast cannon, arising from the crystalline arrangement and unequal cooling of the different parts. The *Chase* is the long, tapering portion of the gun extending from the curve to the muzzle. The principal injury to which the chase is liable in smooth-bore guns arises from the striking or balloting of the projectile against the side of the bore; and the thickness of metal should be sufficient to resist it. The *Muzzle* is the increased thickness of metal which terminates the chase. Inasmuch as the metal situated immediately at the muzzle is supported

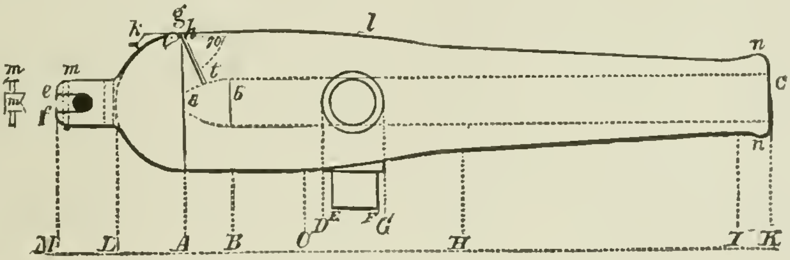


Fig. 1.

Breech, A M, including —	Hemisphere or Base of A L.	Cylinder, A C.	Base-ring, A.
	Breech,	Curve, C H.	Trunnion, E F.
	Cascabel, L M.	Chase, H I.	Rimbase, D G.
	Jaws, e f	Muzzle, I K. { n, Swell of Muzzle. c, Face of Muzzle.	Breech Sight-mass, k.
	Block and Pin, m m.	Bore, a c. { Cylinder, b c. Gomer-chamber, a b.	Front Sight-mass, l.
			Lock-lugs, g.
			Vent, h t.

only in rear, it has been usually considered necessary to increase its thickness to enable it to resist the action of the projectile at this point; but in the larger guns the *swell of the muzzle* has been omitted. The swell strengthens a part liable to be impaired by an enemy's fire, and affords, also, a good position for a notch or sight.

The *Trunnions*, Fig. 1, are two cylindrical arms attached to the sides of a cannon, for the purpose of supporting it on its carriage. They are placed on opposite sides of the piece, with their axes in the same line and at right angles to its axis. The size of the trunnions depends on the recoil of the piece and the material of which they are made. The resistance which a cylinder opposes to rupture is proportional to the cube of its diameter; on the supposition that the strain is proportional to the weight of the charge, it is usual to make the diameter of the trunnions equal to the diameter of the bore. The position of the trunnions, with reference to the axis of the bore, influences the amount of recoil and the endurance of the carriage. By reference to Fig. 2 it will be seen that if the axis of the trunnions be placed below the

FIG. 2.

axis of the piece, the resultant of the force of the charge, which acts against the bottom of the bore, will act to turn the piece around its trunnion, and cause the breech to press upon the head of the elevating-screw with a force proportioned to the length of the lever-arm, or distance between the axes. The effect will be to throw an additional strain on the carriage by pressing down the rear part of it, and checking the recoil. If the trunnions be placed above the axis of the piece, rotation will take place in the opposite direction, and the effect of the discharge upon the carriage and recoil will be reversed. By placing the two axes in the same plane, the force of the charge will be communicated directly to the trunnions, without increasing or diminishing its effect on the carriage or recoil; this position is given to them in all guns in the United States service. The unequal distribution of the weight of a cannon, with reference to the axis of the trunnions, is called the preponderance. It is the pressure which the breech portion of the gun, when horizontal, exerts on the elevating arrangement. To ascertain the preponderance practically, support the gun at the trunnions as freely as possible, and bring it horizontal by means of a long handspike in the bore. Place a platform-scale under the breech, and fix a block of wood on it, touching the gun underneath at the elevating-point. The handspike being then removed from the bore, the pressure on the block is indicated on the arm of the scale, and is the preponderance of the gun.

In larger guns destined to throw heavy elongated projectiles, where the weight of the charge increases rapidly in comparison with the caliber, the chamber is of the size of the bore, and lately useful results have been obtained by making the chamber of greater diameter than the bore. The necessity for a small chamber being assumed, and its capacity decided upon, the determination of its proper form will be governed by several conditions. 1st. The chamber must be deep enough to receive a cartridge manageable in length. 2d. As the chamber adds materially to the length of the bore, it must evidently be no deeper than the service of the gun renders necessary. 3d. It should contain no angles, on account of the well-known tendency of a split to begin at an angle; hence the bore should terminate in a curve, the hemisphere, semi-ellipsoid, paraboloid, and ogival being those most frequently used. The shape of the chamber generally in use for S. B. guns is conical. The particular kind of chamber represented in the drawing is called a *Gomer Chamber*, after its inventor. Its principal advantages are, distributing the force of the charge over a large portion of the surface of the projectile, thereby rendering it less liable to break if it be hollow, and reducing the windage when the projectile is driven down to its proper place.

The *Vent* is the channel passing through the metal, from the exterior of the breech into the bore, by means of which fire is communicated to the charge. The size of the vent should be as small as possible, in order to diminish the escape of gas and the erosion of the metal, which results from it. In naval ordnance vents are constructed two tenths of an inch in diameter. In bronze pieces the heat of the inflamed gases would be sufficient to melt the tin and rapidly enlarge its diameter. For this reason they are *bouched* by screwing in a perforated piece of pure wrought-copper, called the *vent-piece*. This arrangement allows the vent to be renewed when too much enlarged by continued use. Copper vent-pieces are especially necessary in rifle-guns, in consequence of the prolonged action of the gas arising from the resistance of the projectile. In the largest caliber the interior orifice is lined with *platinum*. The upper portion of the copper is replaced by steel to obtain a harder surface for receiving the blow of the hammer. Some guns have two unbouched vents, situated on opposite sides of the axis of the bore, and inclined at an angle of 70 degrees with that axis. The one on the right side is bored entirely through; the other is simply initiated to give it direction. When the open vent is too much enlarged by wear for further use it is closed with melted zinc, and the other is bored out. Each vent should endure about five hundred service-rounds. In smooth-bore cast guns the vent enters the bore very near the bottom; the vents of heavy built-up guns are usually bored vertically, and in such a position as to strike the cartridge at about four tenths of its length from the bottom of the bore, it having been ascertained by experiment that the ignition of the charge at about this point realizes the greatest projectile force that can be produced by a given charge: but in some of the heaviest rifled guns and in most breech-loading guns the vent is bored in the line of the axis through the breech, and is termed an *axial vent*. Experiment shows that the actual loss of force by the escape of gas through the vent, as compared to that of the entire charge, is inconsiderable, and it may be neglected in practice.

In designing a gun, it is necessary in the first place to endeavor to determine what thickness of metal is required for that part of the gun surrounding the seat of the charge, for it is here where the greatest strain from the explosion of the charge is exerted. No precise rules can be laid down for the regulation of this thickness in various kinds of ordnance, as so much depends upon the physical properties of the material used. The general results of experience, or of experiments carried on for the purpose of establishing this point, can alone furnish us with the requisite data. The amount of metal in a gun must depend upon the charge, the weight and form of the projectile, the material employed, and the method of construction. When a charge of gunpowder is ignited in the bore of a gun, the gas exerts equal pressures in all directions, and therefore, neglecting windage, the pressure in the bottom of the bore is equal to that on the base of the projectile, and the pressures on the top and bottom as well as those on the sides of the bore balance each other. The metal of a gun is subjected to two principal strains: one a *transverse* or *tangential*, which tends to rend the metal lengthwise, or from end to end; and the other a *longitudinal*, tending to fracture the gun across, or to drive out the breech. As the projectile moves towards the muzzle, so will the space in which the gas is confined be increased, and the pressure be decreased; the portion of metal surrounding the space originally occupied by the cartridge, and a little in front of it, is that upon which the *maximum pressure* from the gas is exerted. The maximum pressure will be influenced by the nature of the powder, the resistance offered by the projectile to motion, and by the absence or amount of windage.

Many experiments have been made to determine the gradual decrease of strain upon the metal of a piece of ordnance, from breech to muzzle. The first were accomplished by perforating a gun in several places from the exterior to the bore, at right angles with the bore, and successively screwing a pistol-barrel containing a steel ball into each perforation, and discharging the gun with the pistol-barrel at the different perforations: the relative velocities with which the pistol-ball (received by a pendulum) is forced out at these different positions indicate the force exerted there to burst the gun, and consequently the relative strength of metal necessary in the various parts to resist explosion. The following formula, which is used for calculating the exterior form of cannon of large caliber for the land service, was deduced by Captain Rodman from a series of original experiments on the strength of hollow cylinders, etc.:

$$C = \frac{2pr\sqrt{l}}{S} \times \frac{R\sqrt{L}}{\left((R-r)(2rL+R)(R+r)(R-r)\frac{l^5}{L^5}\right)},$$

in which C is a constant quantity, $r =$ interior radius and $R =$ exterior radius, $p =$ pressure of gas, $l =$ length of bore pressed required to fully develop transverse resistance, $L =$ length of bore corresponding to assumed values of R, $S =$ tensile strength of metal, and $l' =$ length of bore subjected to maximum pressure. The pressure of the gas is supposed to vary inversely as the square root of the length of the bore behind the projectile. The exterior forms thus obtained are entirely made up of curved lines.

For many years cast-iron cannon have been made in Sweden of a form nearly approaching that called for by the actual pressure of the powder at different points of the bore (Fig. 3). In the construction of bronze guns, the thickness of the metal at the neck,

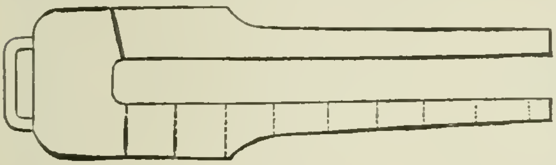


FIG. 3.

or thinnest part, is about equal to $\frac{5}{11}$ of that at the first reinforce, or $\frac{5}{11}E$, given in the empirical formula $E = D\sqrt{\frac{C}{\frac{1}{2}P}}$, in which D represents the diameter of a solid cast-iron shot suited to the bore, C the proof-charge, and P the real weight of the projectile.

The weight of a cannon is determined by the weight of the projectile, the maximum velocity it may be necessary to communicate to it, and the extent of the recoil. The extent of the recoil being limited by the conditions of the service, the weight of the piece may be deduced from the principle that action and reaction are equal and opposite; or that the quantity of motion expended on the inertia of the piece and carriage, and friction, is equal to that expended on the projectile, and the air set in motion by the charge. Let w be the weight of the projectile; v, its maximum velocity; c, the weight of the charge of powder; N, a constant linear quantity, representing the velocity communicated to the piece by a unit of weight of the charge, arising from its action on the air, independent of the projectile (for American powder this has been found by experiment with the gun and ballistic pendulums to be equal to 1600 feet); f, the velocity lost by a unit of mass, from the friction of the carriage on ordinary ground; W, the weight of the piece; V, velocity of recoil; C, the weight of the carriage; R, the pressure of the trail on the ground, arising from the recoil; and g, the force of gravity. From the principle before enunciated, we have

$$\frac{w}{g}v + \frac{c}{g}N = \frac{(W+C)}{g}V + \frac{(W+C+R)}{g}f;$$

or, by reduction,

$$W = \frac{wv + cN - CV - Cf - Rf}{V+f}.$$

For field-guns the velocity of the recoil should not exceed 12 feet. See *Exterior Form of Cannon*, *Firing*, *Injuries to Cannon*, *Ordnance*, and *Pointing*.

CANNONADE.—The act of discharging shot or shells from cannon for the purpose of destroying an army, or battering a town, ship, or fort; usually applied to an attack of some continuance. Also written *Cannonry*.

CANNON-BALL — CANNON-BULLET. — Properly speaking, this term should only be applied to spherical solid projectiles; but it appears to have become generic, extending to elongated bullets for rifled guns, and even to hollow projectiles. Technically, balls are termed "solid shot," or simply "shot," to distinguish them from hollow projectiles. They are now universally made of cast-iron, though stone was formerly employed, and was used in some instances by the Turks as late as 1827. In South America balls of copper were formerly used, this metal being there, at that period, cheaper than iron. Elongated bullets for rifled cannon are now frequently, especially by English writers, termed "bolts." These are often made flat-pointed or angularly pointed, to more readily penetrate iron plating. See *Projectiles*.

CANNON-BASKETS.—The old English phrase for gabions. Not used at present.

CANNON-CLOCK.—A cannon with a burning-glass over the vent, so as to fire the priming when the sun reaches the meridian. Such pieces were placed in the Palais Royal and in the Luxembourg, at Paris.

CANNONEER—CANNONIER—CANONNIER. — An artillery-man or gunner. In 1671, during the administration of Louvois in France, the name of *Canonniers* was given to the first company of the regiment of the king's fusileers; in April, 1693, this regiment was named *Artillerie Royal*, but the first company retained the name of *Canonniers*.

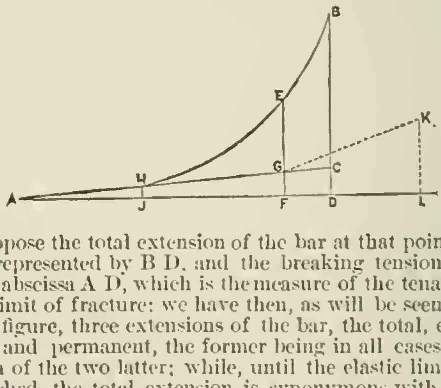
CANNON-FOUNDING.—Since Sir William Armstrong succeeded, by a process first brought under the notice of the British Government in 1854, in making of malleable iron a field-gun of far greater efficiency than any previously in use, cannon-founding has in most European countries gradually ceased. This manufacture, which was formerly an important one, is, however, still carried on in the United States, Sweden, and Russia, all three of which countries produce cast-iron of a very superior quality. Cannon are cast in molds of loam or sand prepared with the help of a pattern. They are usually cast vertically, with an extra mass of metal poured in at the top end of each mold to secure by its pressure greater solidity in its walls, as is often done in the case of a hydraulic cylinder. This superfluous portion is, of course, afterwards removed. Cannon are, or at least were, often cast solid with the same object, and afterwards bored, although it is by no means certain that such are generally sounder or of closer texture than those which are cast hollow. In either case the inner surface of the cannon is accurately finished with a boring-tool to the required caliber, and the outer surface turned. Brass, or rather bronze, cannon were usually cast in loam by means of a clay model on which were often stuck ornamental figures in wax, these being melted out of the mold before casting. In the United States, cast-iron guns are made by Rodman's process; that is, they are cast hollow on a core-barrel which is filled with water.

This is applied so as to cool the metal of the gun in layers, thus modifying the initial strain upon it, and producing the best result that can be obtained from cast-iron for ordnance purposes. Within the last few years guns as large in the bore as 20 inches have been cast by this method at Pittsburg, and one of the same size has been made by it in Russia. The latter weighs 44 tons, throws a spherical ball of 9 cwt., and took 3½ months to finish. Its cost was not more than one fourth that of a built-up gun of steel for the same weight of projectile. Many of the earlier pieces of ordnance, it is curious to observe, were made of hooped bars, in which one can trace the germ of the process by which the Armstrong gun is made. Indeed, it is doubtful if any modern plan of constructing large guns was not tried in olden times, as is seen by an examination of the different kinds of old cannon still preserved. These, however, had to be constructed without the aid of the steam-hammer and other appliances, which render such work comparatively easy nowadays, and were accordingly deficient in strength. The earlier wrought-iron cannon were eventually superseded by those made of cast-iron and bronze, but not entirely for some considerable time after the latter had been in use. The mortar, which was introduced about the commencement of the fourteenth century, appears to have been not only the most ancient form of cannon, but the first European fire-arm as well. From the beginning of the fifteenth century, cannon were cast in bronze, and some of great size are stated to have been used at the siege of Constantinople in 1463. Probably hand-cannon of cast-iron date as far back as bronze guns, and at any rate we know that large and excellent cannon were made of cast-iron in the early part of the sixteenth century, they having been used at Flodden, and England having even then acquired a reputation for this kind of ordnance. Cannon-founding has therefore been practiced for nearly 500 years; and although the art is now to all appearance doomed to decay, no one can predict, in these days of metallurgical wonders, what further change improvements in the manufacture of iron and steel may bring about as respects the making of large fire-arms. In order that the cast guns made on the old system may still be available for some purposes in modern warfare, Colonel Hay Campbell, some years ago, proposed a plan for lining bronze, and Major Palliser another for lining cast-iron cannon with a tube of wrought-iron. Some have been transformed on the Palliser system, which consists in boring a certain thickness off the old gun and forcing a coiled wrought-iron barrel into the interior, and are said to have given very remarkable results as regards endurance. Certain peculiarities in the manufacture of special kinds of ordnance are noticed in the articles relating to them. See *Ordnance*.

CANNON-LOCK.—A contrivance, like the lock of a gun, placed over the vent of a cannon to explode the charge.

CANNON-METALS.—The qualities of metals with which we are more particularly concerned in the construction of ordnance are the physical properties of malleability, ductility, hardness or softness, toughness, elasticity, and tensile strength, while we must also understand what is meant by tenacity and elastic limit as applied to metals. *Malleability* is the property of being permanently extended in all directions without rupture by pressure (as in rolling) or by impact (as in hammering). It is opposed to *brittleness*, which is the tendency to break more or less readily under compression either gradual or sudden. *Ductility* is the property of permanently extending or drawing out, by traction, as in wire-drawing. A metal is said to be *soft* when it yields easily to compression without breaking, and does not return to its original form on the removal of the compressing stress. These terms are, of course, only comparative; thus we have hard leads and soft leads, while any sort of lead whatever is soft as compared with wrought-iron, which latter again is called soft when we compare it with cast-iron. Steel is called *soft* or *low* when the proportion of carbon contained in it is small, and *hard* or *high* when the contrary is the case, because when treated in a similar manner one variety is much harder than the other. It should, however, be remembered that a tolerably soft steel may be made very hard by tempering. It is easy to understand what *toughness* means, but not so easy to define exactly what it is. Dr. Young gives the following explanation of the term as applied to steel: "Steel, whether perfectly hard or of the softest temper, resists flexure with equal force when the deviations from the natural state are small, but at a certain point the steel, if soft, begins to undergo an alteration of form; at another point it breaks if much hardened, but when the hardness is moderate it is capable of a much greater curvature without permanent alteration or fracture, and this quality, which is valuable for the purposes of springs [and also for gun-barrels], is called toughness, and is opposed to rigidity and brittleness on the one side and to ductility on the other." *Elasticity* is the property possessed by a metal of resisting permanent deformation when subjected to a stress, and is measured by the ratio of stress to strain, so that the modulus of elasticity is equal to the cotangent of the angle H A J, in the following figure. The *elastic limit* of a metal is the tension which causes permanent elongation, and in the figure is represented by the abscissa A J. *Tenacity* is the tension required to produce rupture, and is represented by the abscissa A D. *Tensile strength* we shall employ to denote the work done upon the metal to produce rupture by traction. It would be measured in the figure by the area A B D.

In order to understand these several terms more clearly, let us take the figure below, in which the abscissæ represent the tensions, and the ordinates the extensions, of a bar of metal (experimentally determined) corresponding to the tensions. If the bar be subject to a constantly-increasing tension, the extension is at first in a constant ratio to the tension, increasing after a certain point in a varying ratio. This point, represented in the diagram by the extension, H J, and measured by the tension represented by the abscissa A J, is termed the elastic limit. After this point is reached, the extensions increase in a higher ratio for every increment of tension, and the line joining the ordinates becomes a curved line, as shown by H B in the figure. As we continue to increase the tension, we arrive at a point where the bar will fracture.



Suppose the total extension of the bar at that point to be represented by B D, and the breaking tension by the abscissa A D, which is the measure of the tenacity or limit of fracture; we have then, as will be seen by the figure, three extensions of the bar, the total, elastic, and permanent, the former being in all cases the sum of the two latter; while, until the elastic limit is reached, the total extension is synonymous with the elastic extension. The ordinates of the curve (a straight line as far as H) A B represent the total extensions, and the ordinates of the straight line A C the elastic extensions of the bar, while the work required to produce rupture is measured by the area A B D, which thus measures the tensile strength.

Similarly, the work necessary to produce a total extension, E F, is measured by the area A F E. If we move the tension represented by A F, after the bar has been extended by E F, the greatest extension of the bar will not exceed F G; then reimpose it and once more remove the tension, the bar will revert to its former length. Here, of the total work done on the bar represented by the area A F E, that portion corresponding to the area H E G has been absorbed by it and applied to the rearrangement of its molecules, being the measure of the loss sustained in the tensile strength of the bar. Its tenacity may, however, be increased, and we see that its elastic limit is so, for any ductile metal increases (within certain limits) in elastic limit and ultimate strength (as represented by the tenacity), though not in absolute or tensile strength (as shown by the total work required to produce rupture), when subjected to drawing, hammering, or rolling. In fact, a material strained beyond its elastic limit will exhibit the same characteristics as an originally harder metal. To return, however, to the case in the figure. Suppose we now subject the bar, which has been elongated by the permanent extension E G, to a greater tension, then the total extensions may be represented by the same line G K, and we see that the breaking tension, shown by A L, is greater than before. The total work to produce rupture will now be represented by the area A K L, which, however, can never exceed the mechanical work represented by A B D, or, what is the same thing, F G K L cannot exceed B D F E, so that the absolute or tensile strength of the metal is not increased by permanent extension beyond its original elastic limit, although its tenacity and elasticity may be increased by the operation.

To recapitulate, then, we must remember that increase in the tenacity (or breaking tension) and limit of elasticity do not necessarily imply greater working strength in a given bar of metal. We do, however, gain very much, as we all know, by subjecting metals to the operations of rolling, hammering, etc., for we obtain a higher limit of elasticity and tenacity in smaller bulk by making the mass more homogeneous. It will be seen that the tensile strength of a metal is by no means the same as the tenacity, which latter is often termed tensile strength, and which is measured here by the weight in tons that a bar of a square inch in sectional area will just support without breaking. The former is proportional to an area and the latter to a straight line in the figure above. In order to fracture steel of great tenacity, less work may in fact be done than is required to fracture a similar bar of soft wrought-iron. Again, the elasticity of the iron may equal that of the steel, but the limit of elasticity might be very different in the two cases. The elasticity is measured by the cotangent of the angle C A D, in the figure, while the elastic limit is represented by the tension measured by the line A J, and the work required to overcome it by the area H A J.

The metals used for the construction of ordnance are bronze, cast or wrought iron, steel, and numerous alloys of these metals. These are treated under specific headings. The fitness of metals for cannon depends chiefly upon their elasticity. It also depends, if the least possible weight is to be combined with the greatest possible preventive against explosive bursting, upon the ductility of the metal. Hardness to resist compression and wear is the other most important quality. Cast-iron has the least ultimate tenacity, elasticity, and ductility; but it is harder than bronze or wrought-iron, and it is homogeneous. The unequal cooling of solid castings leaves them under initial rupturing strains; but hollow casting and cooling from within remedies this defect and other minor defects. Wrought-iron has the advantage of a considerable amount of elasticity, a high degree of ductility, and a greater ultimate tenacity than cast-iron; but as large masses must be welded up from small pieces, the want of homogeneity becomes a serious defect. Another serious defect of wrought-iron is its softness and consequent yielding under pressure and friction.

Low cast-steel has the greatest ultimate tenacity and hardness; and, what is more important, it has the highest elasticity. It has the great advantage over wrought-iron of homogeneity in masses of any size. It is, unlike the other metals, capable of great variation in density, by the simple processes of tempering and annealing, and, therefore, of being adapted to the different degrees of elongation to which it is subjected in either solid or built-up guns.

Bronze has greater ultimate tenacity than cast-iron, but it has little more elasticity and less homogeneity; it has a high degree of ductility, but it is the softest of cannon-metals, and is injuriously affected by the heat of high charges. In view of the duty demanded of modern guns, it would seem that simple cast-iron is too weak, although it can be used to advantage in combination with other metals. Wrought-iron in large masses cannot be trusted, and is in all cases too soft. Bronze is impracticably soft, and destructible by heat. Low steel is, therefore, by reason of the associated qualities, which may be called strength and toughness, probably the only material from which we can hope to maintain resistance to the high pressure demanded in modern warfare. See *Bronze*, *Cast-iron*, *Iron*, *Ordnance*, *Wrought-iron*, and *Steel*.

CANNON-PERER.—An ancient piece of ordnance throwing stone shot.

CANNON-PRIMERS.—Both friction and electric cannon-primers have recently been remodeled and improved. Those made since 1882 differ from those formerly made in having the body, branch, and the serrated wire of the friction-primer made from cartridge copper instead of brass, and in having the end stopped with a tinfoil cup instead of a wax plug. To perfect and reduce the cost of their fabrication, improvements have been made in several details of the process. The platinum-wire "bridge" of the electric primer has been reduced in diameter and to one fourth of its former length. New machines

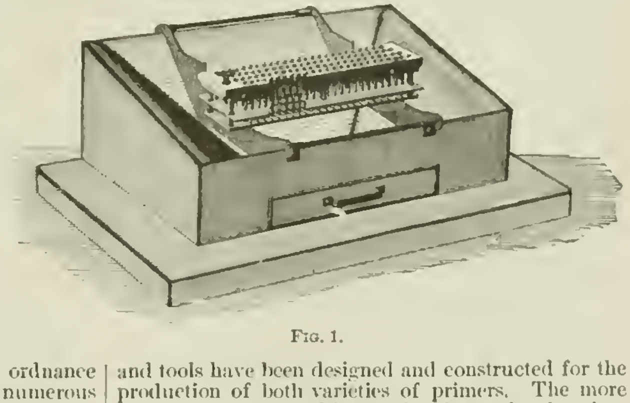


Fig. 1.

and tools have been designed and constructed for the production of both varieties of primers. The more important of the machines and tools are the charging-machine, the foiling-machine, and their auxiliary tools.

The charging-machine, represented in Fig. 1, is a tin-lined wooden hopper, having two supports across its upper end, serving to hold a rack containing the primers to be charged and the charging-tool. A drawer under its lower end receives the overflow of powder from the charging-tool. "Rifle" powder is used to charge the primers, each charge containing about 7 grains by weight. Before charging, both varieties of primers are "primed," the friction-primer, with its serrated wire, packed in friction composition, of which the tersulphide of antimony (sulphuret) is the basis; and the electric primer, with its bridge of platinum wire and copper connecting-wires, a small wisp of gun-cotton being attached to the bridge. For the charging and foiling operations the primers are assembled in a metal rack which has dowels to receive and adjust the charging-tool over the open ends of the primers. The charging-tool consists of two plates held together, but susceptible of a slight movement of the upper upon the lower one. The upper one has tapered holes and the lower one cylindrical holes, corresponding to the primers in the rack. The upper one measures the charges, and its movement, by means of a cam and thumb-nut, upon the lower one, opens or closes the lower end of the tapered charge-holes. The charging-tool, having the charge-holes closed at the bottom by its motion on the lower plate, is placed upon the rack of primers. A quantity of powder is poured over the charge-holes, filling them, and the surplus is stroked off with a straight-edge. The upper plate is now moved so as to empty the charges, through the holes in the lower plate, into the primers. A slight shock or jar settles the powder in the primers, the charging-tool is lifted off, and the rack passed to the foiling-machine.

The new foiling-machine, represented in Fig. 2, is a

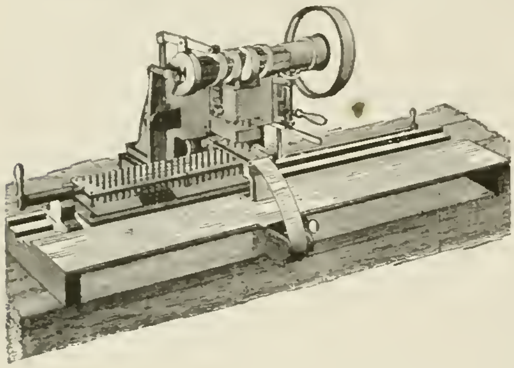


FIG. 2.

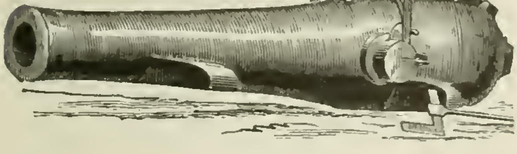
double-action press, arranged to feed the rack of primers horizontally under a gang of punches and dies. The tinfoil, in the form of a coiled ribbon about 1.25 inch wide and .004 inch thick, is fed in between the punches and dies. These cut and form the tinfoil cup, in the usual way, and the cupping-punch presses it down through the die into the end of the primer, at the same time slightly compressing the charge of powder. The tinfoil cup is subsequently secured by means of shellac varnish. The cartridge copper is a more durable metal than brass, which is liable to rot and break easily after long storage or exposure to the atmosphere. The tinfoil stopper is more permanent under wide variations of temperature than the wax one. At high temperatures the latter was sometimes softened and forced out by the expansion of the air, etc., confined in the primer. The charging-machine insures a full charge of powder in every primer, which was not made certain by the old method of charging them by hand. The foiling-machine effectually closes the charge in the primer until it is exploded. It is not improbable that many reported failures of both varieties of primers may have been due to an insufficient charge, if not to its entire absence; and that primers fully charged have often lost their powder by the displacement of the wax stopper. These machines and tools not only work with certainty, but with a rapidity that effects a considerable saving in the cost of their products. See *Electric Primer* and *Friction-primer*.

CANNON-ROYAL.—An old grade of service-cannon, 8½ inches bore and firing a 66-pound shot.

CANNON-SIGHTS.—In order that a projectile fired from a gun may strike a required object, it is necessary to adjust the line of fire with reference to the horizon and the vertical plane passing through the object in such a manner that the trajectory will reach it. The axis of the gun is not visible, and it is necessary to resort to notches or sights on the exterior surface to determine practically the position of the axis. The line of metal is a visual line, joining the notches cut on the highest points of the base-ring and swell of the muzzle. The inclination of the line of metal to the axis of the bore varies in guns of the same class as well as in those of different classes. Aiming, therefore, by the line of metal cannot be relied on for definite ranges; besides that, within those ranges it is apt to mislead by giving too much elevation to the piece. If a gun be pointed at an object by means of a line of metal, it will be seen, by prolonging that line and the axis of the bore, that the latter will pass over the object.

A dispart is a piece of metal placed on the top of the gun to give a line of sight parallel to the axis of the bore. Half the difference between the diameters of the gun at the base-ring and swell of the muzzle, or at any intermediate point on the line of metal, will give the proper height of the dispart-sight at the point where the least diameter was taken. In the absence of other means of sighting, wooden dispart-sights lashed on the cylinder can be used. A narrow groove in the upper surface of the wooden sight, made to coincide with the plane of the line of sight marked on the gun, will assist in getting the true direction. The guns of the Dahlgren pattern are cylindrical for a certain distance forward of the base-line, always giving a line of sight parallel to the axis of the bore. Guns are marked on the top of the base-ring, the sight-masses, and swell of the muzzle, by notches, which indicate a vertical plane passing through the axis of the bore at right angles to the axis of the trunnion. In range at level, the bore being horizontal, the dispart-sight is directed at a point above the water-line or point struck equal to its own distance above that line. If the gun is pointed by dispart directly at an object, the projectile will fall short, more or less, depending upon the distance. In pointing by dispart, therefore, it is necessary to direct the sight a certain height above the object, to allow for the fall of the projectile during flight; the height to be pointed above must depend upon the distance of the object. To facilitate the operation of pointing guns according to the distance of the object aimed at, sights are prepared and fitted to each gun, distinguished as top sights and side sights. The top or ordinary sights consist of two pieces of bronze gun-metal, one of which, called the front sight, is a fixed point, firmly secured to the sight-mass, upon the upper surface of the gun between the trunnions. The other, or rear sight, is a square bar or stem with a head, in the top of which is a sight-notch. It is set diagonally so as to expose two faces to the rear; the rear angle chamfered, to afford a bearing for the clamp-screw. This bar or stem is made to slide in a vertical plane, in the sight-box fixed to the breech-sight mass, and is held at the various elevations for which it is graduated by means of a thumb-screw. Its length is sufficient for all the elevation which can be given—about 5°—before the muzzle appears above the front sight, after which a long wooden sight must be used, graduated for the whole length of the gun, using the notch in the muzzle. The rear sight may be said to be a tangent to an arc the radius of which is the distance from the outer point of the front sight to the fore part of the rear sight, and the divisions are calculated accordingly; this distance is called the short radius. The rear sight is marked on the two rear faces for every hundred yards; on one face for the shell and its proper charge, and on the other for shot. The wooden rear sight may be said to be a tangent to an arc of which the radius is the distance from the notch on the swell of the muzzle to the front of the rear sight; this distance is called the long radius. The rear sight is set at an angle of 60°, so that it may slide up and down without touching the breech of the piece. Every gun is furnished with two sight-bars, a long wooden and a short brass one; the longer is used for ranges over 1700 yards; for all ranges less than this, which is the extreme distance at which accurate practice may be expected at sea, the short bar is used. Pivot-guns are fitted with side-sights placed on the side of the breech, and on the trunnion or rimbase. The advantage of this arrangement is that the sights can be used at any elevation; for, being placed at the side of the gun, the muzzle of the piece does not interfere with the line of sight when pointing. The sights of all howitzers are fitted in this way; the front sight is a notch in a small mass cast on the muzzle; the rear sight is a bronze cylinder pointed at the top and marked for seconds to correspond with the Bormann fuse. The rear sight slides in a small mass cast on the breech, and is held by a thumb-screw. Sights for Parrot M. L. R. guns consist of a fixed sight upon the rimbase, and a movable sight in a socket which is screwed into the breech of the gun. The movable sight is furnished with a sliding eye-piece, and is graduated up to 10°. The eye-piece is also capable of lateral adjustment to allow for the *drift* as far as 10′, and for the effect of the wind. It is desirable that the sights should be placed on both sides of the breech; otherwise, in firing from a port at extreme train, there may be considerable loss of lateral aim. The 8-inch M. L. rifle is furnished with the usual top sights, and has also side sights, the rear one being set at a permanent angle of 1° 47′. The rear sight is a rectangular bar with a square shoulder slotted for a movable eye-piece to allow for deviations due to the force of the wind, etc. It is marked on the rear side for charge, kind of powder and shell; on the left side, range in yards, time of flight in seconds, charge, kind of powder and shell, and initial velocity; the same on the right side for a different charge, and in front for degrees of elevation. The front sight is screwed into the rimbase and is pierced with two holes connected by a slit.

The adjustment of cannon-sights requires the most careful attention. The bore having been thoroughly cleansed, its axis is leveled by inserting a small steel T-square in the bottom of bore at the muzzle. The square itself is first leveled by placing an ordinary level on the transverse branch. When the T-square is leveled, the level is then placed on the longitudinal branch of the T-square lengthwise with the bore of gun, and the axis of gun is then leveled by striking the chocks previously placed on each side under chase of gun, which of course either raise or lower the muzzle. When the gun has been leveled as to axis of bore, it is to be leveled as to axis of trunnions. To level as to axis of trunnions: First, scrape off the paint on top of each trunnion, then place the trunnion-square as seen in the drawing, and put the spirit-



level on it as at S. Adjust the piece by means of the chocks under the trunnions until they are horizontal. This leveling the gun by axis of trunnions may throw the axis of the gun out of level, in which case return to that, and then to the other, approximating closer and closer each time until the gun is leveled. If the gun be lying on wooden skids, the leveling must be verified from time to time, as the great weight will cause it to sink trifle by trifle, thus throwing the level out. The distance that the sights should be apart is furnished by authority. With a straight-edge mark off this distance, and drill a hole for the front sight. Then counter-bore the front sight. As soon as it is screwed in, lay one end of the straight-edge on it, and its other end on the notch of rear sight. Place a level on the straight-edge. Now the level will generally be found to be slightly out, and it can be brought to a level by either screwing the front sight up or down as occasion requires, or by cutting down the notch of the rear sight if it should want to be lowered at that end. For side sights, the rear bar is generally supplied with the proper firing-distances marked on it. Whenever a sight-bar is received already marked with ranges, the level should never be remedied by cutting away the shoulder of the bar, as the edge of the shoulder is the initial point from which the bar is marked. If, however, the sight-bar is marked after it is fitted to the gun, the shoulder can be thinned down. The leveling-bar is not used in side-sighting a gun. The straight-edge is now applied as before, resting on front sight and notch of rear sight-bar, and verified as to the level of that plane. If the spirit-level remains at level, the gun is properly sighted as to the level of sights. See *Pointing*.

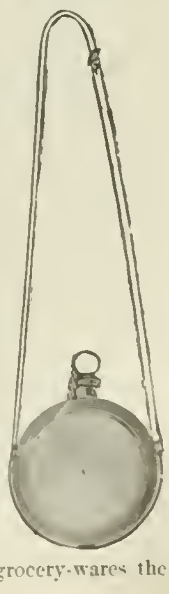
CANONNIERE.—1. A name formerly given to a tent which served to shelter four canonniers, but later the term was applied to all infantry tents which contained seven or eight men. 2. An appellation formerly given to a gun-proof tower; it also designated an opening in the walls of cities, forts, etc., through which the defenders of these places could fire on an enemy without being exposed.

CANONNIERS GARDES-COTES.—Guards instituted in 1702 by Louis XIV. of France for the service of coast-batteries. They are similar to the Artillery Coast Brigade in the British service.

CANTABRI.—A rude race of mountaineers in ancient Spain, of Iberian origin, and who lived in the district now known as Burgos, and on the coasts of the Bay of Biscay, which derived from them its name, *Oceanus Cantabricus*. The most important of their nine towns were Juliobrica (near the source of the Ebro), Vellica, and Concana. The Cantabri are described as like the Scythians and Thracians in hardihood and martial character, sleeping on the bare earth, enduring extreme pain without a murmur, and, like most savages, leaving agricultural toil to their women. Their bravery was evinced in the Cantabrian war, a six years' contest with the Romans, begun under Augustus, and concluded by Agrippa, 25–19 B.C. Tiberius afterwards stationed garrisons in the towns of the conquered Cantabri; but some portion retreated into their fastnesses among the mountains, where they preserved their independence. They are supposed to be the ancestors of the Basques.

CANTABRUM.—A large banner used during the time of the Roman emperors, and borne on festive occasions.

CANTEEN.—1. A vessel used by soldiers to contain whatever beverage may be obtainable on the march or in the field. It is sometimes of tin, sometimes of wood. In the British army, the canteen is a wooden vessel, holding about three pints, painted blue, and inscribed with the number or designation of the regiment, battalion, and company to which the soldier belongs.



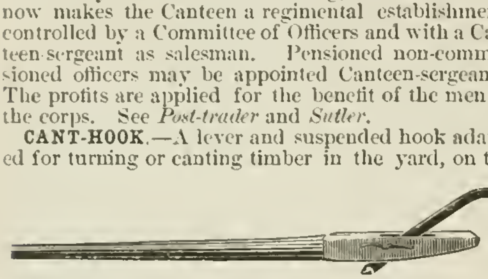
2. A leathern or wooden chest, divided into compartments, and containing the plate and table-equipage for a military officer when on active service.

3. In the French barracks, the canteen is a sort of club-room for the whole regiment. The Cantinier is a non-commissioned officer, who acts merely as an agent for all, selling the liquors and commodities at prime cost.

4. In the British service, a refreshment-house in a barrack, for the use of the soldiers. The chief articles of food are supplied to the troops direct by the government; but wine, malt liquor, and small grocery-wares the

soldier is left to buy for himself; and the Canteen is, or is intended to be, a shop where he can make these purchases economically without the necessity of going beyond the precincts of the barrack. No soldier is obliged to buy anything at the Canteen; he may lay out his small sums elsewhere if he prefer. Formerly the Canteens were under civilians called Canteen-tenants, and spirits were sold. Between the years 1836 and 1845 it was found that among 112 Canteens in the United Kingdom the rent and head-money paid varied from £4 per annum (one at Guernsey) to £1344 per annum (one at Woolwich); they brought in collectively to the government about £70,000 annually. Great intoxication having resulted from the sale of spirits at the Canteens, the War Office prohibited such sale in 1847; as a consequence, the rents had to be lowered to the extent of £20,000 in the following year, the Cantineers finding their profits much reduced. The rent paid was found to be injurious to the soldiers, who were charged higher prices within the barrack than without, and who were thence driven to places where dangerous temptations are at hand. The result of this system being undeniably bad and demoralizing, the War Office now makes the Canteen a regimental establishment, controlled by a Committee of Officers and with a Canteen-sergeant as salesman. Pensioned non-commissioned officers may be appointed Canteen-sergeants. The profits are applied for the benefit of the men of the corps. See *Post-trader* and *Sutler*.

CANT-HOOK.—A lever and suspended hook adapted for turning or canting timber in the yard, on the



Cant-hook.

skids, or on the mill-carriage. The term is also applied to a sling with hooks for raising and tilting casks to empty them.

CANTINIERE.—Women who are authorized to establish themselves in the barracks or follow the troops in time of war, selling them liquors and provisions. The *cantinières*, whether attached to regiments or barracks, are selected from the wives of non-commissioned officers or privates, and wear a uniform. See *Virandière*.

CANTLE.—The hind-bow or protuberance of a saddle. Sometimes written *Cantel*. See *Saddle*.

CANTON.—In Heraldry, the canton occupies a corner of the shield, either dexter or sinister, and in size is the third of the chief. It is one of the nine honorable ordinaries, "and of great esteem."

CANTONMENTS.—When, after long fatigues, some repose must be given to an army, it must be dispersed over a sufficient extent for subsistence. This disposition of the troops is termed *cantoning*, and the camps occupied, *cantonments*. This state supposes that the enemy will not for some time be in a condition to attack. Still, even this assurance should not induce any relaxation of proper military precautions to prevent a surprise, and to permit a concentration on some suitable point either for offensive or defensive movements. The dispositions to be made for this purpose resemble, in their principal features, those for one of advanced-posts. Advanced points are held by some of the troops where there is no relaxation of discipline allowed; other points, in their rear, are occupied as supports to the first; and all are connected with some main central position where the army is to be concentrated in case of need. The communications to the rear, at least of all these detached portions, should be kept in good traveling order, and no obstruction to the free movements of the troops be even for an hour allowed to exist. When cantonments are taken up in winter they are termed *winter quarters*. They differ from the preceding only in being often of greater extent; and therefore, from their weakness, requiring all the additional means of defense at hand.

As cantonments are taken up either during seasons when operations cannot be well carried on, or to give the troops some extraordinary repose after a harassing campaign, more advanced-posts will generally be necessary than under ordinary circumstances; and to fulfill their end they ought to be placed on ground favorable to a strong resistance, in order to give the separated corps time to concentrate against an earnest attack of the enemy. A good disposition of stations for outposts, from which the enemy can be seen at a distance; a line of supports placed on strong ground in the rear; easy communications for concentration on the main body; active and vigilant patrols, kept moving not only along the front, but penetrating on the flanks and rear of the enemy, to get wind of his strategical plans: such are the general precautions demanded of its advanced-posts by an army in station for some time. In the disposition of the main force, to concur with the preceding, one precaution should not be omitted in a stay of any duration; and that is, not to allow any one body to remain long enough in a village, or inhabited place, to become in a degree domesticated. Nothing is more likely than this to injure the *morale* of the best troops. The seductions of otherwise harmless pleasures may lead to fatal habits of remissness in duty.

In India, cantonments are *permanent* places, regular military towns, distinct and at some little distances from the principal cities. If on a large scale, such a cantonment contains barracks for European cavalry, infantry, and artillery; rows of bungalows or houses, each inclosed in a garden, for the officers; rows of huts for the native soldiery; magazines and parade-grounds; public offices and buildings of various kinds; and a bazaar for the accommodation of the native troops. During the revolt in 1857–58 most of the outbreaks began in the cantonments. It was in the cantonment outside Cawnpore that Nana Sahib commenced his treachery. See *Camp*, *Field-service*, and *Winter Quarters*.

CANTONNEE.—When, in Heraldry, a cross is placed between four other objects, as, for example, scallop-shells, it is said to be *cantonnée*. See *Heraldry*.

CANTON'S PHOSPHORUS.—A combustible obtained by heating in a close vessel 3 parts oyster-shells and 1 part sublimed sulphur, when the sulphuret of calcium (CaS) is formed, which takes fire when exposed to or thrown into the air. Frequently spoken of as *pyrophorus*.

CANVAS.—A material made from hemp, and much used for artillery purposes, such as the covering of the seats of gun-carriages, caps for sponge-heads, soldiers' bags, aprons for the vents of guns, and paulins for covering stores; it is also used in the manufacture of tents. The canvas in use in arsenals in India is of two kinds—English and that manufactured in the country. The canvas made in India is used for all purposes where rough material would be required, such as artillery-practice curtains, sand-bags, bags for charcoal, etc. The chief places of manufacture of Indian canvas are in Bengal, and at Cuddalore and Travancore, in the Madras Presidency. Being "under canvas" means being in camp or in the field.

CANVAS-BOAT.—A boat has been invented by Colonel R. C. Buchanan, of the United States Army, which has been used in several expeditions in Oregon and in Washington Territory, and has been highly commended by several experienced officers, who have had the opportunity of giving its merits a practical service-test. It consists of an exceedingly light framework of thin and narrow boards, in lengths suitable for packing, connected by hinges, the different sections folding into so small a compass as to be conveniently carried upon mules. The frame is covered with a sheet of stout cotton canvas, or duck, secured to the gunwales with a cord running diagonally back and forth through eyelet-holes in the upper edge.

When first placed in the water the boat leaks a little, but the canvas soon swells so as to make it sufficiently tight for all practical purposes. The great advantage to be derived from the use of this boat is that it is so compact and portable as to be admirably adapted to the requirements of campaigning in a country where the streams are liable to rise above a fording stage, and where the allowance of transportation is small. It may be put together or taken apart and packed in a very few minutes, and one mule suffices to transport a boat with all its appurtenances, capable of sustaining ten men. Should the canvas become torn, it is easily repaired by putting on a patch, and it does not rot or crack like india-rubber or gutta-percha; moreover, it is not affected by changes of climate or temperature. See *Blanket-boats.*

CANVAS CAPS.—Caps used, after having been water-proofed, for covering the mouths of mortars, and for covering sponge-staves.

CAP.—1. A cover for the head, with or without a visor, but without a brim; worn generally by the military. 2. A sheet of lead laid over the vent of a cannon. 3. A copper capsule containing a fulminate, and placed upon the nipple to explode the charge on the fall of the hammer.

CAP-A-PIE.—This term was applied in the Middle Ages to a knight or soldier armed at all points, or from head to foot, as the words imply, with armor for defense, and with arms for offense.

CAPARISON.—The bridle, saddle, and trappings complete of a horse for military service. *Caparisoned,* in Heraldry, is said of a war-horse completely furnished for the field.

CAP-CORD.—A gilt cord worn on the forage-cap as an ornament. The drawing represents the new pattern cap-cord recently adopted in the United States army. A similar cap-cord is worn by United States Naval Officers.

Cap-cord.

CAPELINE.—A helmet without a visor, nearly in the form of a round head. It was formerly much worn by the infantry.

CAPITAL.—In fortification, a capital is an imaginary line dividing a defense-work into two similar and equal parts. The capital of a bastion is a right line drawn from the point or salient angle to the middle of the gorge or entrance in the rear. The capital of a ravelin is a right line drawn from the re-entering angle of the counterscarp to the salient angle of the ravelin. See *Field-fortification.*

CAPITAL PUNISHMENT.—The law on this subject in England is contained in the 19th of the Articles of War now in force, which prescribes death as the punishment of the following offenses, or such other punishment as by a Court-Martial shall be awarded: (1) Any officer or soldier who shall excite or join in any mutiny or sedition in any forces belonging to Her Majesty's Army, or Royal Marines, or who shall not use his utmost endeavors to suppress it, and knowing of it, shall not give immediate information of it to his Commanding Officer; or (2) who shall hold correspondence with, or give advice or intelligence to, any rebel or enemy of Her Majesty; or (3) who shall treat with any rebel or enemy without Her Majesty's license, or license of the Chief Commander; or (4) shall misbehave himself before the enemy; or (5) shall shamefully abandon or deliver up any garrison, fortress, post, or guard committed to his charge; or (6) shall compel the Governor or Commanding Officer to deliver up or abandon such place; or (7) shall induce others to misbehave before the enemy, or abandon or deliver up their posts; or (8) shall desert Her Majesty's service; or (9) shall leave his post before being regularly relieved, or shall sleep on his post; or (10) shall strike or offer any violence to his Superior Officer, being in the execution of his office, or shall disobey any lawful command of his Superior Officer; or (11) who, being confined in a military prison, shall offer any violence against a visitor or his Superior Military Officer, being in the execution of his office.

By Article 20 it is declared that no judgment of death by a Court-Martial shall pass, unless two thirds at least of the officers present shall concur therein; and by Article 21 it is provided that judgment of death may be commuted for penal servitude for any term not less than four years, or for imprisonment for such term as shall seem meet. It would appear that the employment of a soldier in the service subsequent to his arrest on a capital charge may operate as a remission of the sentence of death. This is illustrated by the following case, mentioned by Mr. Prendergast in his *Law Relating to Officers in the Army.* In 1811 Private John Weblin of the 3d Buffs was sentenced to be shot. The Commander-in-Chief, the Duke of Wellington, in his "remarks" upon the proceedings, took notice that, through some extraordinary inattention, the prisoner had actually been permitted to serve in an engagement with the enemy after he had been put into arrest for his crime. On this ground the Duke pronounced that he was under the *necessity* of *pardoning* the prisoner. In the army, capital punishment is inflicted by the offender being either shot or hanged—the latter being the more disgraceful mode of execution.

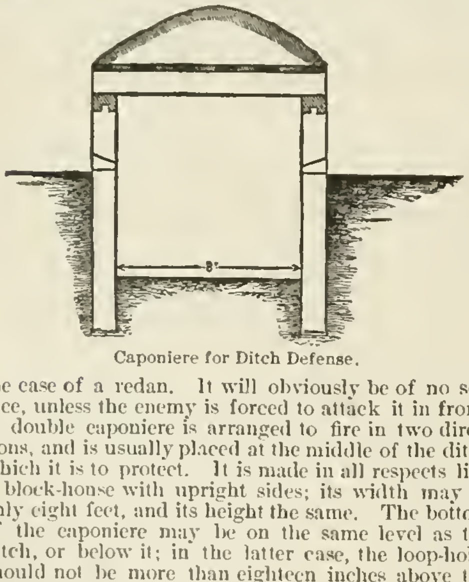
Under the laws of the United States, capital punishment may be inflicted for treason, murder, arson, rape, piracy, robbery of the mails with jeopardy to the lives of persons in charge, rescue of a convict going to execution, burning a vessel of war, and corruptly destroying a private vessel. Until within a few years capital punishment was the rule for the highest crimes in all the States, but it was abolished in Wisconsin and in Maine in 1874, and had been about that time abolished in Iowa; but in the latter State it was restored in 1878, the argument showing from the record that during its abolition crimes of violence had largely increased. Under the present law a year must intervene between the sentence and execution, and the term may be further extended by reprieve. There is much difference of opinion as to the effect of the abolition of the death-penalty, and perhaps no settled conclusion can be reached. The effect of its abolition has not thus far supplied any very strong reasons for the stand of those who would abolish it altogether. Perhaps the most notable suspension of this punishment in all history was during the War of the Rebellion in the United States, when, in the face of the most powerful, open, and dangerous treason, not one person was deliberately executed for that crime, the extreme penalty visited even upon the captured leader of the Rebellion, being the loss of the political (but not the personal) rights of a citizen.

CAPITULATION.—A treaty consisting of several specified conditions. In the military sense of the word, a capitulation is a treaty of surrender to an enemy. When a place can no longer be defended, on account of failure of ammunition or provisions, or the progress made by the besieging party, a white flag is commonly put up, as a sign that the besieged are willing to capitulate. According to the kind and degree of peril in which the fortress is placed, so are the terms which the Governor may reasonably expect from his successful opponent. Sometimes the arms and military stores are left to the besieged, but more frequently they are taken by the besiegers, except articles of private property belonging to the officers and men. The "honors of war," the marching out with drums beating and colors flying, are usually stipulated for, unless the conqueror exacts very severe terms. The mildest form of a capitulation is a *Convention*, agreed to when the conqueror is not strong enough to insist on stringent conditions. See *Armistice*.

CAP OF MAINTENANCE.—A cap of crimson velvet lined with ermine, with two points turned to the back, originally only worn by Dukes, but afterwards assigned to various families of distinction. Those families who are entitled to a cap of maintenance place their crests on it instead of on a wreath. According to Sir John Fearne, the wearing of the cap had a beginning from the Duke or General of an army, who, having gotten victory, caused the chiefest of the subdued enemies whom he led to follow him in his triumph, bearing his hat or cap after him in token of subjection and captivity. Most of the reigning Dukes of Germany, and various families belonging to the peerage both of England and of Scotland, bear their crests on a cap of maintenance. Sometimes called *cap of dignity*.

CAPONIERES—CAPONNIERES.—The surest defense for a ditch is a good flanking arrangement of the work itself; but as this is in many cases impracticable, owing either to the relief or to the plan, flank defenses must be procured by a construction made in the ditch. Several methods may be resorted to for this purpose, termed *caponieres*, *scarp*, and *counterscarp galleries*.

The caponiere is a work made across the ditch, and may be either single or double. A single caponiere is nothing more than a defensive stockade, or palisading, made at the extremity of a ditch, as in



Caponiere for Ditch Defense.

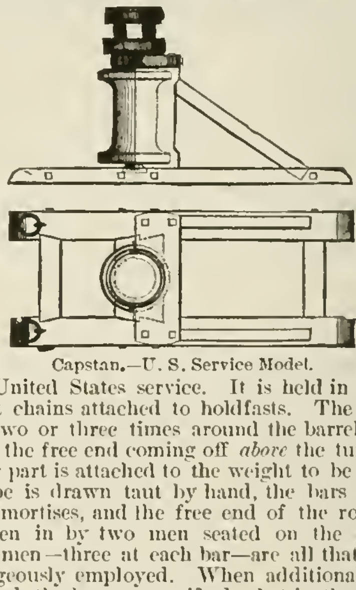
the case of a redan. It will obviously be of no service, unless the enemy is forced to attack it in front. A double caponiere is arranged to fire in two directions, and is usually placed at the middle of the ditch which it is to protect. It is made in all respects like a block-house with upright sides; its width may be only eight feet, and its height the same. The bottom of the caponiere may be on the same level as the ditch, or below it; in the latter case, the loop-holes should not be more than eighteen inches above the level of the ditch, to prevent the enemy from using them against the assailed within. In the former, a small ditch should be made round the caponiere, and the earth from the ditch be thrown against its sides. The plan of the caponiere should be arranged to admit of being flanked by a defensive stockade, placed at the foot of the scarp; for this purpose the end next to the counter-scarp should be in the form of a salient flanked by the stockade. To prevent the enemy from jumping on the caponiere from the crest of the counterscarp, a space of at least twelve feet should be left between the two. Moreover, the top of the caponiere should be covered from the enemy's artillery, either by the counterscarp crest or by a glacis. The communication to the caponiere from the work may be by a timber gallery under the parapet, formed of frames and a sheeting similar to the construction used for a powder-magazine.

CAPOTE.—A heavy coat with a hood, worn by soldiers, sailors, and others when on duty.

CAP-SQUARE.—In artillery, that part of the iron-work of a gun-carriage which folds or laps over the exterior portion of the trunnions of a piece of ordnance, when it is laid in its bed or carriage. The cap-square is secured by a key or some other stronger contrivance. This fastening prevents the gun from jumping out of its trunnion-bed.

CAPSTAN.—A hoisting or hauling machine, consisting of a drum set vertically and revolved by hand-spikes. The capstan differs from the windlass in having an upright axle, the bars being placed in the sockets of the drum-head and revolving horizontally as the men walk around, pushing the bars before them and winding the cable on the whelps. The capstan has many advantages, among which may be enumerated—compactness; facility for allowing a large number of men to work at it simultaneously; continuity of its work, as the bars do not require to be unshipped after making a quarter of a revolution. Frequently, when moving artillery, it becomes necessary to improvise a capstan with a limber. To do so, dismount a siege-limber; place a half-block under the pintle and each axle-arm, close to the shoulder. Drive a stout stake in rear of each axle-arm against the half-blocks. The pole is turned *from the weight*, its axis in the direction of it. Lay the wheel on the pintle, outside down, and secure four handspikes to the spokes and felloes, dividing the circumference into four equal parts. Take a round turn with the fall around the lower part of the nave, the free end coming off below. The man who holds on to the fall sits on the end of the pole. Keep the fall as high as the nave and clear of the ground. The power is multiplied fifteen times.

The drawing represents the capstan as employed


Capstan.—U. S. Service Model.

in the United States service. It is held in position by stout chains attached to holdfasts. The rope is passed two or three times around the barrel of the capstan, the free end coming off *above* the turns; the standing part is attached to the weight to be moved. The rope is drawn taut by hand, the bars inserted into the mortises, and the free end of the rope held and taken in by two men seated on the ground. Twelve men—three at each bar—are all that can be advantageously employed. When additional power is required, the bars are swifted; that is, the ends of the bars are lashed together with ropes, by which additional men are enabled to take hold.

To use the gin as a capstan, put it together on the ground in the usual manner; place the feet of the legs toward the weight, and secure them well with stakes against the cross-bars, feet, and head of the gin; rig the fall as usual, and attach the hook of the lower block to a rope of suitable strength running to the weight to be moved; the windlass is worked in the same manner as when the gin is standing. Or the gin, with its pry-pole in the direction of the weight to be moved, may be raised almost to its usual position for hoisting. A block is hooked to the clevis, and through it the rope is passed from the weight to the windlass; the latter is worked as usual. *See Mechanical Maneuvers.*

CAPSULES.—Copper caps for percussion-locks. Not used at present.

CAPTAIN.—This is perhaps the most general designation given to an officer of land forces; something equivalent to it being found in most European languages. As a word, it simply means a *head* or *leader*, and may be applied to a Chief over any number of men. *Captain-general* is in some countries a very high command. In the time of Queen Elizabeth there was, among other high military officers, a Captain-general of footmen. In the organization of the British army at the present day, there is one Captain to every *company* of infantry, and every *troop* of cavalry. Formerly every battery of artillery had two Captains—a first and a second, the latter being called Captain-lieutenant. Now, the first in command has the title of Major, and the second that of Captain. The first in command of a battery of artillery, even when styled Captain, was considered higher than a Captain of infantry or cavalry, and was privileged to be mentioned by name in military dispatches like Colonels and Majors. The duty of the Captain is to see to the men of his company in everything that relates to discipline, exercises, billeting, pay, settlement of accounts, mess, kit, clothing, arms, ammunition, accouterments, stores, barracks, cooking, etc.; to receive orders concerning these matters from the Major, and to enforce these orders among the men. He is responsible to the Major, and is assisted in his duties by the Lieutenant and Sub-lieutenant. The number of Captains on the peace establishment of the British army, in its several branches, are about 239 Cavalry, 1236 Infantry, 248 Artillery, 115 for Engineers, and 28 for Colonial Corps—1866 in all, in full commission. In the United States army, a Captain is responsible for the camp and garrison equipage and the arms and clothing of his company. The rank is between Lieutenant and Major.

CAPTAIN-GENERAL.—The appellation of a Commander-in-Chief till Marlborough's time, if not later. The rank is sometimes still given on extraordinary occasions. It was borne by the Marquis of Wellesley during his government in India, and is applied to the Governor-general of the Canadas. In the United States, the Governor of a State is Captain-general of the militia.

CAPTAIN-LIEUTENANT.—A rank formerly held in the English army. This position carried the rank of Captain in the Army, similar to what the rank of Lieutenant and Captain does in the Foot-guards at the present day. A Captain-lieutenant did Subaltern's duty in his company, and could hold the post of Adjutant. He was also the Subaltern who commanded the "Colonel's Company" in each regiment of infantry.

CAPTAINRY.—The power or command over a certain district; Chieftainship; Captainship.

CAPTAINSHIP.—The condition, rank, post, or authority of a Captain or Chief Commander. The term also signifies skill in military affairs; as, to show good captainship.

CAPTIVES.—It is laid down by Blackstone that, as in the goods of an enemy, so also in his person, a man may acquire a sort of qualified property in him as a captive, or prisoner of war—at least till the ransom of the captive is paid. In Scotland all legal proceedings against a captive are stopped till his liberation, although in some cases execution against his estate may proceed.

CAPTIVITY.—The state of being a prisoner, or of being in the power of the enemy, by force of the fate of war.

CAPTURE.—Prize taken in time of war. The law on this subject is stated with precision in a paper addressed on behalf of the British Government to the American Ambassador at London in September, 1794: "When two powers are at war, they have a right to make prizes of the ships, goods, and effects of each other, upon the high seas. Whatever is the property of the enemy may be acquired by capture at sea; but the property of a friend cannot be taken, provided he observes his neutrality. Hence the Law of Nations has established that the goods of an enemy on board the ship of a friend may be taken, that the lawful goods of a friend on board the ship of an enemy ought to be restored; that contraband goods going to the enemy, though the property of a friend, may be taken as prize: because supplying the enemy with what enables him better to carry on the war is a departure from neutrality."

During the Russian war in 1854 there appeared in the *London Gazette*, under date the 28th March of that year, a declaration stating, *inter alia*, that Her Majesty would waive the right of seizing enemy's property laden on board a neutral vessel, unless it be contraband of war, and that it was not Her Majesty's intention to issue letters of marque for the commissioning of privateers. The right of seizing enemy's property on board a neutral vessel, whether contraband of war or not, had always before been maintained by England. On the re-establishment of peace with Russia, a treaty was signed, and the following declarations adopted: 1. Privateering is and remains abolished; 2. A neutral flag covers an enemy's goods, with the exception of contraband of war; 3. Neutral goods, with the exception of contraband of war, are not liable to capture under an enemy's flag; 4. Blockades, in order to be binding, must be effectual—that is to say, maintained by force sufficient to prevent effectually access to the coast of the enemy. See *Booty* and *Prize*.

CAPTURED PROPERTY.—A victorious army appropriates all public money, seizes all public movable property until further direction by its government, and sequesters for its own benefit or that of its government all the revenues of real property belonging to the hostile government or nation. The title to such real property remains in abeyance during military occupation, and until the conquest is made complete. A victorious army, by the martial power inherent in the same, may suspend, change, or abolish, as far as the martial power extends, the relations which arise from the services due, according to the existing laws of the invaded country, from one citizen, subject, or native of the same to another. The commander of the army must leave it to the ultimate treaty of peace to settle the permanency of this change. It is no longer considered lawful—on the contrary, it is held to be a serious breach of the law of war—to force the subjects of the enemy into the service of the victorious government, except the latter should proclaim, after a fair and complete conquest of the hostile country or district, that it is resolved to keep the country, district, or place permanently as its own and make it a portion of its own country.

As a general rule, the property belonging to churches, to hospitals or other establishments of an exclusively charitable character, to establishments of education, or foundations for the promotion of knowledge, whether public schools, universities, academies of learning or observatories, museums of the fine arts or of a scientific character, may be taxed or used when the public service may require it. Classical works of art, libraries, scientific collections, or precious instruments, such as astronomical telescopes, as well as hospitals, must be secured against all avoidable injury, even when they are contained in fortified places whilst besieged or bombarded. If such works of art, libraries, collections, or instruments belonging to a hostile nation or government can be removed without injury, the ruler of the conquering State or Nation may order them to be seized and removed for the benefit of the said Nation. The ultimate ownership is to be settled by the ensuing treaty of peace. In no case shall they be sold or given away, if captured by the armies of the United States, nor shall they ever be privately appropriated, or wantonly destroyed or injured.

The United States acknowledge and protect, in hostile countries occupied by them, religion and morality; strictly private property; the persons of the inhabitants, especially those of women; and the sacredness of domestic relations. Offenses to the contrary shall be rigorously punished. This rule does not interfere with the right of the victorious invader to tax the people or their property, to levy forced loans, to billet soldiers, or to appropriate property, especially houses, land, boats or ships, and churches, for temporary and military uses. Private property, unless forfeited by crimes or by offenses of the owner, can be seized only by way of military necessity, for the support or other benefit of the Army or of the United States. If the owner has not fled, the Commanding Officer will cause receipts to be given, which may serve the spoliated owner to obtain indemnity.

The salaries of civil officers of the hostile government who remain in the invaded territory, and continue the work of their office, and can continue it according to the circumstances arising out of the war—such as judges, administrative or police officers, officers of city or communal governments—are paid from the public revenue of the invaded territory, until the military government has reason wholly or partially to discontinue it. Salaries or incomes connected with purely honorary titles are always stopped. There exists no law or body of authoritative rules of action between hostile armies, except that branch of the law of nature and nations which is called the law and usages of war on land. All municipal law of the ground on which the armies stand, or of the countries to which they belong, is silent and of no effect between armies in the field.

Slavery, complicating and confounding the ideas of property (that is, of a *thing*) and of personalty (that is, of *humanity*), exists according to municipal or local law only. The law of nature and nations has never acknowledged it. The digest of the Roman law enacts the early dictum of the pagan jurist, that "so far as the law of nature is concerned all men are equal." Fugitives escaping from a country in which they were slaves, villains, or serfs, into another country, have, for centuries past, been held free and acknowledged free by judicial decisions of European countries, even though the municipal law of the country in which the slave had taken refuge acknowledged slavery within its own dominions. Therefore in a war between the United States and a belligerent which admits of slavery, if a person held in bondage by that belligerent be captured by or come as a fugitive under the protection of the military forces of the United States, such person is immediately entitled to the rights and privileges of a freeman. To return such person into slavery would amount to enslaving a free person, and neither the United States nor any officer under their authority can enslave any human being. Moreover, a person so made free by the law of war is under the shield of the law of nations, and the former owner or State can have, by the law of postliminy no belligerent lien or claim of service.

All wanton violence committed against persons in the invaded country, all destruction of property not commanded by the authorized officer, all robbery, all pillage or sacking, even after taking a place by main force, all rape, wounding, maiming, or killing of such inhabitants, are prohibited under the penalty of death, or such other severe punishment as may seem adequate for the gravity of the offense. A soldier, officer or private, in the act of committing such violence, and disobeying a Superior ordering him to abstain from it, may be lawfully killed on the spot by such Superior. All captures and booty belong, according to the modern law of war, primarily to the government of the captor. Prize-money, whether on sea or land, can now only be claimed under the local law.

Neither officers nor soldiers are allowed to make use of their position or power in the hostile country for private gain, not even for commercial transactions otherwise legitimate. Offenses to the contrary committed by commissioned officers will be punished with cashiering or such other punishment as the nature of the offense may require; if by soldiers, they shall be punished according to the nature of the offense.

Crimes punishable by all penal codes, such as arson, murder, maiming, assaults, highway robbery, theft, burglary, fraud, forgery, and rape, if committed by an American soldier in a hostile country against its inhabitants, are not only punishable as at home, but in all cases in which death is not inflicted the severer punishment shall be preferred.

CAPUCHIN.—A piece of mail generally worn in early days under the great bascinet.

CAPUCHONS.—A society formed in France, from 1181 to 1183, for the suppression of the brigandage of the *Routiers;* they exterminated 7000 brigands in an engagement near Verdun.

CARABINE A TIGE.—A very ancient and celebrated rifle. The tige is a sort of small anvil growing like a stem out of an ordinary flat breeching, so that the powder-charge, instead of resting centrally, is distributed all around the tige. Notwithstanding the great military defects of this stem-principle, the carabine à tige has been recently and extensively employed by the French infantry.

CARABINEERS—CARBINEERS.—Dragoons armed with carbines, who occasionally acted as infantry. They are said to have derived their designation from the Arabs, among whom the *Carabins* or *Karabins* were light horsemen, stationed at outposts to harass the enemy, defend narrow passes, etc.; in action, they took the place of skirmishers. A corps under the same name was raised in France in 1560; but the designation has not been much used in that country since the introduction of Hussars and Lancers. In the English army, Carabineers was at one time a frequent designation for cavalry; but now there is only one regiment, the 6th Dragoon Guards, known by this title; and the distinction between them and other cavalry is little more than nominal.

CARABINS.—Light horsemen, sometimes called *Karabins*, among the Arabs, who were stationed at outposts to harass the enemy, defend narrow passes, etc.; in action they took the place of skirmishers. Troops called *Carabins*, a sort of light cavalry from Spain, are first mentioned in England in 1559.

CARACOLE.—In horsemanship, a sudden half-turn sometimes performed in an attack of cavalry to mislead the enemy as to the point at which the assault is to be made.

CARAVAN.—The name given to the assemblages of troops or travelers which at stated times traverse the deserts of Asia and Africa. Many caravans are entirely for the purposes of trade, the merchants associating themselves for mutual help and protection. A caravan sometimes has as many as 1000 camels, which follow each other in single file, so that it may be a mile or more in length. The most celebrated caravans are those formed by pilgrims going to Mecca, particularly those which annually assemble at Cairo and at Damascus. The latter consist of 30,000 to 50,000 pilgrims, and is under the special protection of the Turkish Sultan. The caravan by which the Persians travel to Mecca starts from Bagdad, and is the vehicle of a very important trade. The great Indian caravan to Mecca, which started from Muscat, has been long given up. Mecca, upon the arrival of the caravans, bringing goods from so many different parts of the world, presents all the appearance of a vast fair. The trade between Tripoli and the interior of Africa is exclusively carried on by caravans, likewise that between Darfur and Egypt. The great trade between Russia and China is also a caravan trade. In the East, caravans in which the camels have a load of 500 to 600 lbs. are called *heavy* caravans; *light* caravans are those in which the camels have only half that weight, so that the daily journeys may be longer. *Heavy* caravans travel from 17 to 18 miles a day; *light*, from 22 to 25. The caravans are generally conducted with great regularity, and assemble at and start from stated places on stated days. The leader of the Mecca caravans is called Emir-el-Hadsch, i.e., Prince of the Pilgrims. In trade-caravans, a leader, who is called Karwan-Baschi, is elected by the merchants from their own number.

Among the Knights of Malta, caravans meant the troops of Knights appointed by the Order to serve in garrisons, and also the cruises of their galleys against the Turks.

CARBINE.—A small-arm with a short barrel, adapted for the use of cavalry, and having a bore of .44 to .50 inch, or thereabout. Carbines appear to have come into notice in the army of Henry II. of France, 1559. The arm was 3½ feet long, and the practice was to fire and fall back behind the rear rank, who fired and followed suit. The troops were light cavalry, and the arm seems to have had a wheel-lock. The term now is applied to a short gun adapted for cavalry, of which many breech-loading varieties have been tried in the United States army with greater or less success. Previous to the general introduction of breech-loaders, the fire-arm in common use for cavalry, as well as engineers and heavy artillery, was a species of carbine denominated *musketoon*, differing from the musket only in length and in the fact that the arm for the cavalry was provided with a sling-bar for more convenient carriage on horseback; those for the engineers and artillery were generally furnished with sword-bayonets. These all appear to have corresponded nearly in caliber and general dimensions with the modern French *carabine*. The ramrod of the muzzle-loading carbine is attached to the barrel by a swivel, which permits it to be handled freely, but at the same time prevents it from falling to the ground. The carbine is secured to the person of the soldier by the sling, which hooks on to a ring moving on a swivel-bar attached to the left side of the carbine, thereby affording a play to the piece in loading and firing. See *Carabineers* and *Springfield Carbine*.

Carbine.

CARBON.—One of the elementary substances largely diffused in nature. It occurs uncombined in the mineral graphite, or black-lead, and in the diamond, which is pure crystallized carbon. It is much more abundant, however, in a state of combination. United with oxygen, it occurs as carbonic acid (CO_2) in the atmosphere, in natural water, in limestone, dolomite, and ironstone. In coal it is found combined with hydrogen and oxygen; and in plants and animals it occurs as one of the elements building up wood, starch, gum, sugar, oil, bone (gelatine), and flesh (fibrine). Indeed, there is no other element which is so characteristic of plant and animal organisms, and it ranks as the only element never absent in substances obtained from the two kingdoms of organic nature. Wood-charcoal, coke, lamp-black, and animal charcoal are artificial varieties, more or less impure, of carbon. The atomic weight or equivalent of carbon is 6 (new system 12); the specific gravity greatly varies; that of the diamond is 3.330 to 3.550 (water being 1.000), and of graphite 1.800. Carbon in its ordinary forms is a good conductor of electricity; in the form of diamond it is a non-conductor. Of heat, the lighter varieties of carbon, such as wood charcoal, are very bad conductors; graphite in mass has very considerable conducting powers. At ordinary temperatures all the varieties of carbon are extremely unalterable: so much so that it is customary to char the ends of piles of wood which are to be driven into the ground, so as by this coating of non-decaying carbon to preserve the interior wood; and with a similar object the interior of casks and other wooden vessels intended to hold water during sea-voyages are charred (coated with carbon), to keep the wood from passing into decay, and thereby to preserve the water *sweet*. Its power of arresting odors and colors likewise varies much. In the simple property even of combustion there is a marked difference. Wood-charcoal takes fire with the greatest readiness, bone-black less so; then follow in order of difficulty of combustion—coke, anthracite, lamp-black, black-lead, and the diamond. Indeed, black-lead is so non-combustible that crucibles to withstand very high heats for prolonged periods without breakage or burning are made of black-lead; and the diamond completely resists all ordinary modes of setting fire to it. In the property of hardness, carbon ranges from the velvet-like lamp-black to diamond, the hardest of gems. In 1879 it was announced that a method of producing pure crystallized carbon, or diamond, had been discovered in Glasgow. See *Charcoal*.

CARBON TOOL-POINT.—An application of the diamond to mechanical purposes. These points are much used in the armory to point, edge, or face tools for drilling, reaming, sawing, planing, turning, shaping, carving, engraving, and dressing flint, grindstones, whet-stones, emery, corundum, tanite, or tripoli-wheels, iridium, nickel, enamel, steel, hardened or otherwise, chilled iron, copper, or other metals.

CARCAIRE.—The spur of the Middle Ages, composed of a shank, a spur-neck, and a rowel.

CARCAS.—The name given to a quiver during the Middle Ages. Now obsolete.

CARCASS.—In military pyrotechny a hollow case of iron, sometimes globular and sometimes ovate, filled with combustibles. It is fired from a mortar. Its chief use is to ignite buildings in the enemy's quarter, and to give sufficient light to aim the shot and shells. Carcasses are said to have been first used by one of the princely ecclesiastics of Germany, the Bishop of Munster, when he fought against the Duke of Luxembourg at Groll, in 1672. The oval carcasses, being uncertain in their flight, are now nearly abandoned. The round carcasses now made are chiefly those here indicated:

Diameter.	Composition.	Weight.
13 inch	18 lbs.	213 lbs.
10 "	7 "	100 "
8 "	3 "	51 "
5 "	19 ozs.	17 "
4⅗ "	7 "	9 "

In the United States service the composition is the same as for port-fires, mixed with a small quantity of finely-chopped tow, and as much white turpentine and spirits of turpentine as will give it a compressible consistency. The composition is compactly pressed into the shell with the drift, so as to fill it entirely; one of the sticks is then inserted into each fuse-hole with the points touching at the center so that when withdrawn corresponding holes shall remain in the composition. In each hole thus formed three strands of quick-match are inserted and held in place by dry port-fire composition, which is pressed around them. About three inches of the quick-match hangs out when the carcass is inserted in the piece; previously to that it is coiled up in the fuse-hole, and closed with a patch of cloth dipped in melted kit. A common shell may be loaded as a carcass by placing the bursting-charge on the bottom of the cavity, and covering it with carcass-composition driven in until the shell is nearly full, and then inserting four or five strands of quick-match, secured by driving more composition. This projectile, after burning as a carcass, explodes as a shell. See *Case shot*, *Compositions*, *Fire-works*, *Projectiles*, and *Shells*.

CARCHERA.—A name given by the Corsicans to their cartridge-belts. Now little used.

CARDUCHI.—A warlike people once inhabiting the mountains of Kurdistan, supposed to have been the ancestors of the Kurds of the present day. The Greeks, in the famous Retreat of the Ten Thousand, had to pass through their country, and were greatly harassed by them.

CARE OF SMALL-ARMS.—To clean the barrel—1. Draw a rag through the slot in the head of the ramrod; moisten or wet it with water (warm, if it can be had), and pass it up and down through the bore from muzzle to chamber, until all the residuum is removed, or so moistened and dissolved that it may be entirely removed with a dry rag. 2. Replace the wet rag by a dry one, and wipe the bore as before, changing the rag until the bore is perfectly clean; take pains to see that the well of the receiver is carefully wiped and cleaned out, and that the surfaces of the cam and breech-screw are free from dirt, dust, and rust. 3. Wipe the outside of all metal parts, the bore, well of the receiver, and surfaces of the cam and breech-screw with a slightly-oiled rag. 4. To clean the exterior of the barrel, lay it flat on a bench or board, to avoid bending it. Since the arms now issued are browned, abrasive substances, such as emery, tripoli, sand-paper, etc., should *never* be used to clean them. If the browned parts become rusty, they should be rubbed down with a scratch-brush, and then oiled. 5. After firing, the bore should always be wiped with a wet rag as soon as practicable; afterwards wipe it dry, and then pass into it a rag moistened with oil.

To clean the lock—wipe every part with a moist rag, and then a dry one; if any part of the interior shows rust, put a drop of oil on the point or end of a piece of soft wood dipped into *flour* of emery; rub out the rust clean and wipe the surface dry; then rub every part with a slightly-oiled rag. For the mountings, and all of the iron and steel parts, use the scouring material described in the contents of box of *cleaning materials*. Remove dirt from the screw-holes by screwing a piece of soft wood into them. Wipe clean with a linen rag, and leave the parts slightly oiled. In cleaning the arms, great care should be observed to preserve the qualities essential to service, rather than to obtain a bright polish. Burnishing the barrel (or other parts) should be strictly avoided, as it tends to crook the barrel, and also to destroy the uniformity of the exterior finish of the arm. It is very important to use no other implements than those before mentioned. By using nails to drive out the wires their holes are enlarged. The mainspring should never be heated for the purpose of either raising or lowering its temper; this destroys the elasticity of the spring, and the lock no longer explodes the cartridge. The notches of the tumbler, the mainspring-swivel, and, in general, all the joints of the lock, should be frequently oiled, after first wiping off the hard grease and the dust.

Browned arms are cleaned by rubbing them hard with an oiled rag until the oil is well incorporated with the browning, or by rubbing them with beeswax on a rag or cork. Rifled arms should not have the ramrod sprung in the bore with unnecessary force. It batters the head of the rod and wears injuriously the grooves. The soldier should let the rod slide down gently, supported by the thumb and finger; and the inspecting officer can satisfy himself of the condition of the bottom of the bore by gently tapping with the rod. The face of the breech can be polished, after washing, by means of a cork fixed on the wiper or ball-screw; the polished surface can be seen if the muzzle is turned to the light.

Habitual care in handling is necessary to keep arms in good, serviceable condition. In ordering arms on parade, let the butt be brought gently to the ground, especially when the exercises take place on pavements or hard roads. This will save the mechanism of the lock from shocks, which are very injurious to it, and which tend to loosen and mar the screws and split the wood-work. In stacking arms, care should be taken not to injure the bayonets by forcibly straining the edges against each other. The stack can be as well secured without such force being used. No cutting, marking, or scraping in any way the wood or iron should be allowed; and no part of the gun should be touched with a file. Take every possible care to prevent water from getting in between the lock, or barrel, and stock. If any should get there, dismount the gun as soon as possible, clean and oil the parts as directed, and see that they are perfectly dry before reassembling them.

The iron and brass parts of swords and sabers are cleaned in the same manner as those of muskets. When the oil on the blade of a sword is dried up, it will leave a spot which may be removed by covering it with oil, and, after a short time, rubbing it smartly with a linen rag. When a leather scabbard has become wet, draw the blade and dry the scabbard slowly without heating it; wipe the blade dry, and pass an oiled rag over it and the scabbard before returning the blade. Oil the blades of arms in store, also the scabbards, especially on the seams. See *Cleaning Materials* and *Small-arms*.

CARIPI.—A kind of cavalry in the Turkish army, which, to the number of 1000, are not slaves, nor bred up in the seraglio, like the rest, but are generally Moors, or renegade Christians, who have obtained the rank of Horse-guards to the Grand Seignior.

CARMEL.—The Knights of the Order of Our Lady of Mount Carmel were instituted by Henry IV. of France, and incorporated with the Order of the Knights of St. Lazarus of Jerusalem. The Order of Mount Carmel consisted of 100 gentlemen, all French, who were to attend the king in his wars, and had considerable revenues assigned to them. The Order was confirmed by bull by Pope Paul V., in 1607. The Great Master was created by the king putting about his neck a tawny ribbon, suspending a cross of gold, with the Cloak of the Order, and granting him power to raise 100 knights. None were admitted but those who had four descents of nobility both by father and mother.

CAROLING.—A custom of the ancients before going to war, which consisted of singing, etc.

CARPENTRY.—The art of framing timber for architectural and other purposes. Technically, the term is restricted to the framing of heavy work, such as the roofs, floorings, partitions, and all the wood-work concerned in maintaining the stability of an edifice, while the minor and ornamental fittings are called joinery; but popularly the workman who does either kind of work is called a carpenter. The present article will be confined to a popular description of the most useful methods of framing timber and smaller wood-work. The preliminary preparation of timber is the work of the sawyer, who, by the saw-mill or pit-saw, divides the trunks of trees into planks, etc.; these are further divided by the carpenter, who uses hand-saws of various kinds, according to the work. For dividing wood into separate pieces in the direction of the fiber, the *ripping-saw* is used; for cross-cutting, or sawing thin pieces in the direction of their length, the common *hand-saw* or the finer-toothed *panel-saw;* for making an incision of a given depth, and for cutting small pieces across the fiber, the *tenon-saw*, the *sash-saw*, or *dovetail-saw* is used. These are thin saws, stiffened by a strong piece of metal at the back to prevent crippling. When a curved cut is to be made, a very narrow saw without a back, called a *compass-saw* or a *keyhole-saw*, is used. The general name for these is *turning-saws;* they have their plates thin and narrow towards the bottom, and each succeeding tooth finer, and the teeth are not bent on contrary sides of the plate for clearing, as in broad saws. The surface of wood is smoothed by planing. According to the work, different kinds of planes are used: the *jack-plane*, which is large and rough, for taking away the rough of the saw; the *trying-plane*, for bringing the surface perfectly level and true, or the *long-plane*, for the same purpose, where the work is of great length, as for the joining edges of long boards to be glued together. The *smoothing-plane*, which is much smaller than these, gives the smooth finished surface. The *spoke-shave*, a sort of plane with a double handle, is used for paring and smoothing rounded work. Ornamental moldings are cut by means of *molding-planes*, which have their cutting edges curved to the required pattern. A good stock of these is one of the most expensive items of the tool-chest. The paring of wood, and the cutting of rectangular or prismatic cavities, notches, etc., are done by means of *chisels*. Those for cutting across the fiber are called *firmers* or *paring-chisels;* those for cutting deep and narrow cavities, *mortise-chisels*, which are made very thick and narrow, and fitted in the handles with a strong flange, to bear heavy blows with the mallet. Chisels for paring concave surfaces are called *gouges*. For boring holes, *brad-awls*, *gimlets*, *center-bits*, and *gouges* are used—the two latter are fixed in a *stock* or revolving handle, and are used for large holes. When it is required to ascertain if an angle be square, or of any given inclination, the *square*, or the *bevel* set to the required angle, is applied to test the work as it proceeds. When parallel edges are required, the *marking-gauge* is used to draw the line to be worked to. When a simple straight line is required for working to, a piece of string is chalked, then stretched tightly over the wood and lifted in the middle, when, by its recoil, it strikes the wood and leaves a straight chalked line. The *straight-edge*, a strip of wood with one of its edges perfectly straight, is applied to detect superficial irregularities. The operation of planing the edge of a board straight is called *shooting*, and such edges are said to be *shot*. When the joiner requires to ascertain whether the surface of a piece of wood is all in one plane, he takes two slips of wood with edges perfectly straight and parallel, and of equal width; these slips, called *winding-sticks*, are placed edge upwards, one at each end, across the board, and the workman looks in the longitudinal direction of the board over the upper edges, and if the two edges be not in the same plane, the board is planed down at the elevated parts until it is *out of wind*. For setting work level, a *spirit-level*, set in a wooden frame, or a *plumb-level* is used. When two pieces of timber have to be united at their ends, as in lengthening the beams for roofing, partitions, etc., the operation is called *scarfing*, and the joint a *scarf*. The methods of scarfing are very numerous. That shown in Fig. 1 will serve to illustrate the principle, together with the use of strengthening bolts and straps. The length of the scarf should be, if bolts are not used—in oak, ash, or elm, six times the depth of the beam; in fir, 12 times the depth of the beam.

Fig. 1.

If bolts and indents are combined, the length of the scarf should be—in oak, ash, or elm, twice the depth of the beam; in fir, four times the depth. In scarfing beams to resist transverse strains, straps driven on tight are better than bolts. The sum of the areas of the bolts should not be less than one fifth the area of the beam, when a longitudinal strain is to be borne. No joint should be used in which shrinking or expansion can tend to tear the timbers. No joint can be made so strong as the timber itself. When two pieces of timber are connected so that the joint runs parallel with the fibers of both, it is called a *longitudinal joint;* but when the place of the joint is at right angles to the fibers of both, an *abutting joint*. A very short tenon is called a *stub-tenon*. When a second minor tenon is made projecting from the principal tenon, it is called a *tusk-tenon*. For lighter joiner's work, other methods of framing are used, and adapted to the work—to boards generally instead of beams; thus, for example, the mortise and tenon joint, made oblong instead of square, is used in framing doors, shutters, drawing-boards, or any other kind of extended superficial work liable to warping. An outside frame or skeleton is made with a panel or panels in the middle, and each piece of the frame has the grain at right angles to the piece into which it is mortised, in order that they shall eventually correct the warping. Dovetailing is extensively used for

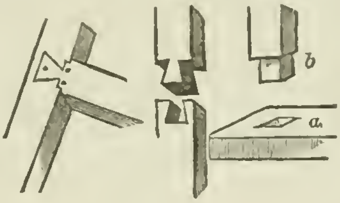


Fig. 2.

connecting boards at right or other angles, as in making boxes, drawers, etc. Common dovetailing is usually glued. Nails or pins and glue are used with the miter and other notched joints. Applications of dovetailing timbers, also the mortise and tenon joint, are shown in Fig. 2. The cavity *a* is the mortise, the projection on *b*, the tenon. The common miter and the lapped miter are shown in Fig. 3. Boards may be united at their edges to form an extended surface, as a flat plank partition, etc., either by simple gluing of the shot edges, by a *rebate*, or by a plowed groove and a plain corresponding projection. The rebate is cut by means of a rebating-plane. The groove, a sort of extended mortise, is cut by a plane with a projecting iron called the *plow*. In all cases where glue is used in joints, it should be applied to both surfaces, which should be rubbed and pressed together until nearly all the glue is forced out, then kept pressed by a cramp or weights. White-lead is used for outside joints. Special departments of this subject are treated under their respective heads.

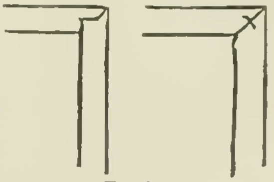


Fig. 3.

CARPET-KNIGHT.—A man who obtains knighthood on a pretense for services in which he never participated.

CARQUOIS.—A quiver of iron, wood, leather, etc., which was worn slung over the right shoulder.

CARRAGO.—A kind of fortification, consisting of a great number of wagons, placed round an army. It was employed by barbarous nations, as, for instance, the Scythians and Goths.

CARREAU.—A bolt or dart, with a large steel head, for a cross-bow. Commonly written *Carre*, *Carrel*, and *Quarreau*.

CARRIAGE-BRIDGE.—A roller-bridge to be moved up a glacis and form a bridge from counterscarp to scarp, for the passage of the attacking column. It has beams and uprights. The latter act as posts, to rest on the bottom of the ditch, and are shiftable to adapt them to the depth of the ditch or fosse.

CARRIAGE DEPARTMENT.—The Royal Carriage Department, at Woolwich, is one of the great national manufacturing establishments maintained for warlike armaments—its duty being the construction of gun-carriages for army and navy, military wagons and vehicles of all kinds, and the joinery of the army generally. The Department was organized as a distinct establishment in 1803, and has been undergoing gradual enlargement ever since. Since the recent introduction of iron carriages for heavy guns, the Department has had a new section added for iron-work. Until 1855 the Board of Ordnance had the direction of this Department, but in that year it passed under the direct control of the Secretary for War, who, since 1869, administers it through the Surveyor-general of the Ordnance. The works, store-rooms, and yards are of vast size, often employing from 2000 to 3000 hands. There are many steam-engines in various parts of the establishment; and the iron and wood cutting and shaping machines are of the highest order of excellence. The internal communications are carried on by locomotives on a tramway of 18-inch gauge. See *Gun-carriages*.

CARRIAGES.—A gun-carriage is designed to support its piece when fired, and also to transport cannon from one point to another. Field, mountain, and siege artillery have also limbers, which form when united with the carriage a four-wheeled vehicle. Sea-coast carriages are divided into *barbette*, *casemate*, and *flank-defense* carriages, depending upon the part of the work in which they are mounted. They are now made of wrought-iron and found to possess lightness, greath strength, and stiffness. The sea-coast carriages are made in a similar manner, and one carriage can be altered to fit another piece by changing the trunnion-plates and transom-straps. The carriage consists of two cheeks of thick sheet-iron, each one of which is strengthened by three flanged iron plates bolted to the cheeks. Along the bottom of each cheek an iron shoe is fixed with the end bent upwards. In front this bent end is bolted to the flange of the front strengthening-plate. In rear the bent portion is longer, and terminated at top by another bend, which serves as a point of application for a lever on a wheel, when running to and from battery. The trunnion-plates fit over the top ends of the strengthening-plates, which meet around the bed, and are fastened to the flanges of the latter by movable bolts and nuts. The *cheeks* are joined together by transoms made of bar-iron. The front of the carriage is mounted on an axletree, with truck-wheels similar to the wooden casemate-carriages. The elevating-screws are of two kinds: one for low angles of elevation, and the second for columbiads where great angles of elevation are required. The elevating arc is made of brass and attached to the upper edge of the right cheek, and may be folded down. It is employed to measure the elevation of the piece.

The very diverse purposes for which military carriages are intended necessitate many varieties of form, as may be seen in the carriages of the field and siege artillery, of the ponton and telegraph equipments, of the transport and ambulance services, etc. The many varieties may be classed under one of two heads, viz.: 1. Those used in the transport of stores; 2. Those which, besides fulfilling the usual functions of a carriage, are especially adapted to facilitate the working of field- and siege-guns. For a description of the carriages of the second class, see the various artillery-carriages. The component parts of the transport-carriages are the following: Axletree (*arms* or *axletree-arms*, *linch-pin*, *body*, *shoulder*, and *point*); axletree-bed; splinter-bar; futchells; sweep-bar; fore-carriage; body (*frame-sides*, *front car-bed*, *hind car-bed*, and *summers*); bolsters; main-pin; stays; knees; sweep-plate and wheel-plate; shaft-irons; scroll-irons; sides, headboard and tailboard; floating raves; and wheels (*nave*, *nave-bands*, *nave-box* or *pipe-box*, *spokes*, *felloes*, and *tire*). In the construction of all carriages the following conditions should be realized: Adaptability of form to the load (including convenience in loading, as well as suitable capacity); strength; stability; durability; ease and convenience of draught; suitability for shipment; facility of repair; and economy of manufacture. The ease of draught is chiefly affected by the following considerations: Weight of carriage and load; height of wheels; mean diameter of pipe-box; degree of smoothness of the surfaces of arm and box, and the quality of the lubricants applied to them; width of tire; position of trace-loops, and inclination of the traces; and the presence or absence of springs. The width and length of carriages should be limited by considerations of convenience in turning and *passing* along narrow roads and other confined spaces. See *Chassis* and *Gun-carriages*.

CARRICK.—An old Gaelic term for a castle or fortress, as well as for a rock in the sea.

CARRICK-BEND.—A knot formed on a bight by putting the end of a rope over its standing part, so as to form a cross: reeve the end of the other rope through the bight, up and over the cross and down through the bight again, on the opposite side from the other end. See *Cordage*.

CARRIER-BLOCK.—A component part of most machine-guns. Directly behind the open barrels a hollow cylinder of metal, called a *carrier-block*, is fastened to the shaft, and in the exterior surface of this carrier-block semi-cylindrical channels are cut, which form trough-like extensions of the cartridge-chambers of the barrels to the rear, and are designed to receive and guide the cartridges while they are being thrust into the barrels, and to guide the empty cases while they are being withdrawn. This block is covered above the frame by the *hopper-plate*, and beneath everything is open. See *Gatling Gun*.

CARRIER-PIGEON.—The term *carrier*, as applied to pigeons, evidently was first employed to signify those breeds that were used to convey or carry messages to their own homes from distant places. In the process of time it has been used by English fanciers to signify a very artificial or high-class breed, the birds of which are never employed for carrying messages, but are valued solely in proportion to the perfection of certain "properties" that they possess. This is an unfortunate circumstance, for by the public at large the term *carrier* is always taken to express the fact that the birds to which it is applied are really those employed to "carry" messages; whereas the long-distance-flying birds, those known more correctly as "homing" birds, or "les pigeons voyagers," are totally distinct. See *Homing Pigeon*.

CARROCCIO.—A very large four-wheeled carriage, which was used by the Crusaders during the Middle Ages. On its platform, which was large enough to hold fifty persons, was erected a tower surmounted with a cross, and a standard, and to it was attached a bell which indicated the passing of the carroccio. Before engaging in battle, an effigy of Christ of life size was placed on the platform, and at its feet an altar; then a mass was held. A number of knights guarded it, and it was drawn by oxen richly caparisoned. Its invention is attributed to the people of Lombardy.

CARRONADES.—Short iron guns invented by Mr. Gascoigne, and named after the Carron Iron-works in Scotland, where they were first made. They are lighter than ordinary guns, and have a chamber for powder, like mortars. They were made standard navy guns in 1779, to be carried on the poop, forecastle, and upper works. Being manageable by a smaller number of hands than guns, and being very useful in close engagements, they were held in much favor during the great war: the seamen called them "smashers." A 68-pounder carronade weighed not much more than half as much as the 42-pounder gun in use in 1779. They range from 68-pounders down to 6-pounders. Some carronades are made shorter with a given bore. Carronades are but little used, except by the English and French. Though valuable at close quarters, they are no match for long guns at a distance; and therefore a ship armed only with carronades would fare badly in a general action. In recent years carronades have to a considerable extent been replaced in the English navy by howitzers, long guns, and shell-guns. See *Ordnance*.

CARROUSEL. — A species of knightly exercise which, down even to the beginning of the eighteenth century, was very common in all the courts of Europe. Carrousel was a kind of imitation of the tournament, and for a time after the discontinuance of the latter seems to have supplied its place. The dresses, for the most part, were those of the knights of former times, and the combatants, or rather competitors, were divided into two parties, usually according to their different nationalities. One of the favorite exercises in France consisted in running at the pasteboard head of a Moor or Turk with a lance, cutting it down with a sword, or firing at it with a pistol. Another of these tests of skill and horsemanship, if not of courage, consisted in carrying off a whole line of rings, which were suspended for the purpose. The carrousel in France was not known earlier than the reign of Henry IV.; but it had existed for some little time previously in Italy. There were brilliant carrousels under Louis XIII., and two celebrated ones were given in honor of Mademoiselle de la Vallière—the one at Paris in 1662, the other at Versailles in 1664. The place where the first of these fêtes was held has ever since been called the Place du Carrousel. A revival of the carrousel was attempted at Berlin in 1750; and in 1828 the Cavalry School at Saumur held one in honor of Madame la Duchesse de Berry. The so-called Eglinton Tournament — an entertainment given some years ago by the chivalrous Earl of Eglinton — was in reality a carrousel.

CARRY ARMS.—A word of command in the Manual of Arms, directing that the musket be taken to the fundamental position, which consists of the piece being held in the right hand; the barrel nearly vertical, and resting in the hollow of the shoulder, the guard to the front: the arm hanging nearly at its full length, near the body, the thumb and forefinger embracing the guard, the remaining fingers closed together and grasping the stock just under the hammer, which rests on the little finger. See *Manual of Arms*, Fig. 1.

CART.—A framework of wood, with sides, front and end boards, placed upon two wheels, and drawn by one or two horses. In the artillery, carts are very generally used. A new-pattern cart was introduced a few years ago into the English service for the carriage of small-arm ammunition in the field. There are about eighteen carts in service of different patterns and for various purposes. See *Hand-cart*.

CARTE.—A movement of the sword in fencing, as tierce and carte. Also a movement in the bayonet-exercise. Frequently written *Quarte*. See *Fencing*.

CARTE-BLANCHE.—In a military sense, a full and absolute power which is lodged in the hands of an officer to act according to the best of his judgment, without waiting for superior instructions or orders. It likewise strictly means a blank paper sent to a person, to fill up with such conditions as he may think proper to insert. In the general acceptation of the term, it implies an authority to act at discretion.

CARTEL.—An agreement between the belligerents for an exchange of prisoners. Sometimes the name is given to a ship, called by the French a *bâtiment parlementaire*, commissioned to convey the exchanged prisoners, or to carry messages to the enemy. A ship, when thus employed, must carry no cargo, ammunition, or implement of war, except one gun for signals.

The following may be taken as a form of the *cartel*, the provisions being liable to modification, according to agreement, by the agents appointed by the proper authorities:

The undersigned, having been commissioned by the authorities they respectively represent to make arrangements for a general exchange of prisoners of war, have agreed to the following articles:

Article 1. It is hereby agreed and stipulated that all prisoners of war held by either party, including those taken on private armed vessels known as privateers, shall be discharged upon the conditions and terms following:

Prisoners to be exchanged man for man and officer for officer; privateers to be placed upon the footing of officers and men of the Navy.

Men and officers of lower grades may be exchanged for officers of a higher grade, and men and officers of different services may be exchanged according to the following scale of equivalents:

A General commanding-in-chief or an Admiral shall be exchanged for officers of equal rank or for sixty privates or common seamen.

A Major General or Flag Officer shall be exchanged for officers of equal rank or for forty privates or common seamen.

A Brigadier General or a Commodore carrying a broad pennant shall be exchanged for officers of equal rank or for twenty privates or common seamen.

A Colonel or a Captain in the Navy shall be exchanged for officers of equal rank or for fifteen privates or common seamen.

A Lieutenant Colonel or a Commander in the Navy shall be exchanged for officers of equal rank or for ten privates or common seamen.

A Major or a Lieutenant Commander shall be exchanged for officers of equal rank or for eight privates or common seamen.

A Captain in the Army or Marines or a Lieutenant or a Master in the Navy shall be exchanged for officers of equal rank or for six privates or common seamen.

Lieutenants in the Army shall be exchanged for officers of equal rank or for four privates or common seamen.

Midshipmen, Warrant Officers in the Navy, Masters of merchant-vessels, and Commanders of privateers shall be exchanged for officers of equal rank or for three privates or common seamen.

Second Captains, Lieutenants, or Mates of merchant-vessels or privateers, and all petty officers of the Navy and all non-commissioned officers in the Army or Marines, shall be severally exchanged for persons of equal rank or for two privates or common seamen; and private soldiers or common seamen shall be exchanged for each other, man for man.

Article 2. Local, State, civil, and militia rank held by persons not in actual military service will not be recognized, the basis of exchange being the grade actually held in the naval and military service of the respective parties.

Article 3. If citizens held by either party on charges of any alleged civil offense are exchanged, it shall only be for citizens. Captured sutlers, teamsters, and all civilians in the actual service of either party, to be exchanged for persons in similar position.

Article 4. The surplus prisoners not exchanged, if paroled, shall not be permitted to take up arms again, nor to serve as military police or constabulary force in any fort, garrison, or field-work held by either of the respective parties, nor as guards of prisons, depots, or stores, nor to discharge any duty usually performed by soldiers, until exchanged under the provisions of this cartel. The exchange is not to be considered complete until the officer or soldier exchanged for has been actually restored to the lines to which he belongs.

ARTICLE 5. Each party, upon the discharge of prisoners of the other party, is authorized to discharge an equal number of their own officers or men from parole, according to the scale of equivalents already agreed upon, furnishing at the same time to the other party a list of their prisoners discharged and of their own officers and men relieved from parole—thus enabling each party to relieve from parole such of their own officers and men as the party may choose. The lists thus mutually furnished will keep both parties advised of the true condition of the exchange of prisoners.

ARTICLE 6. The stipulations and provisions above mentioned to be of binding obligation during the continuance of the war, it matters not which party may have the surplus of prisoners, the great principles involved being—1st. An equitable exchange of prisoners, man for man, officer for officer, or officers of higher grade exchanged for officers of lower grade, or for privates according to the scale of equivalents; 2d. That privateers and officers and men of different services may be exchanged according to the same scale of equivalents; 3d. That all prisoners, of whatever arm of service, are to be exchanged or paroled as soon as it is practicable to transfer them to their own lines; 4th. That no officer, soldier, or employé in the service of either party is to be considered as exchanged and absolved from his parole until his equivalent has actually reached the lines of his friends; 5th. That the parole forbids the performance of field, garrison, police, or guard, or constabulary duty.

ARTICLE 7. For the purpose of carrying into effect the foregoing articles of agreement, each party will appoint two agents, to be called agents for the exchange of prisoners of war, whose duty it shall be to communicate with each other, by correspondence and otherwise, to prepare the lists of prisoners, to attend to the delivery of the prisoners at the places agreed on, and to carry out promptly, effectually, and in good faith all the details and provisions of the said articles of agreement.

ARTICLE 8. In case any misunderstanding shall arise in regard to any clause or stipulation in the foregoing articles, it is mutually agreed that such misunderstanding shall not interrupt the release of prisoners on parole, as herein provided, but shall be made the subject of friendly explanations, in order that the object of this agreement may neither be defeated nor postponed. See *Exchange of Prisoners*, *Parole*, and *Prisoners of War*.

CARTEL-SHIP.—A vessel used in exchanging prisoners or carrying proposals to an enemy. See *Cartel*.

CARTHOUN.—The ancient cannon-royal, carrying a 66-pound ball, with a point-blank range of 185 paces, and an extreme one of about 2000. It was 12 feet long and of 8½ inches diameter of bore.

CARTOUCH.—1. A roll or case of paper, etc., holding a charge for a fire-arm. 2. In gunnery, a case of wood about 3 inches thick at the bottom, bound about with marline, holding about 400 musket-balls, besides 8 or 10 iron balls of a pound each, to be discharged from a howitzer for the defense of a pass, etc. 3. An article of leather to sling over the shoulder of the gunner, who therein carries the ammunition from the tumbril for the service of the artillery when at exercise in the field.

CART-PIECE.—An early battering cannon mounted on a peculiar cart, and thus moved from place to place.

CARTRIDGE.—The requirements of a good service-cartridge are strength, durability, uniform dimensions, and cheapness. Its power should be stored up in as small a space as possible, that a soldier may carry a maximum number of rounds with a minimum effect upon his endurance. It must possess certainty of fire combined with uniform accuracy, range, and penetration. After firing, the shell must be easily extracted from its chamber. To unite all these qualities the greatest care is required in the different processes of manufacture. The materials from which the component parts of the cartridge are made, which are the shell, the primer, the powder, the bullet and lubricant, must be of the best quality. A variation of .001 inch in the thickness of the metal disk from which the shell is drawn, from standard dimensions, produces waste of material and unnecessary wear upon the tools if above the standard, and other complications if below. The priming or explosive compound for igniting the cartridge must be made with such care and of such ingredients as will almost absolutely insure ignition from a blow of calculated strength upon the cup or cap containing it. The component parts of the powder must be sufficiently pure that when incorporated, pressed, and grained, its density may be so nearly constant that a fixed charge will give a nearly constant initial velocity to the bullet, producing a corresponding constant range and accuracy under like conditions of the atmosphere. Electric ballistic machines readily determine the initial velocity, enabling us, by slight variations of the charge, to keep that velocity practically a constant quantity, thus solving the problem of a cartridge with a measured or fixed amount of work stored up in it to be given out with deadly effect when needed. This is the state of perfection to which the cartridge is now made.

The cartridge-cases for ordnance or large guns are chiefly made of serge and flannel, sewn up into the form of a bag, which, supplied with a given weight of powder, is tied round the neck and strengthened by iron hoops. The weight of powder varies from about 300 lbs. for an 81-ton gun, to a few ounces for a mountain-gun.

Cartridges for small-arms which load at the muzzle are usually paper tubes, containing a leaden ball and a few drams of powder. The tubes are made in such a way that the powder has two or three thicknesses of paper around it, while at the mouth of the tube and over the bullet there is only one. The paper over the bullet is lubricated generally with a composition of beeswax and tallow. In loading, the paper at the mouth of the tube has to be twisted or bitten off; the powder is then poured into the barrel, the tube reversed, and the bullet inserted into the muzzle, and the tube broken away. Cartridges for breech-loading small-arms in England are generally formed of a thin sheet of brass coiled into a cylinder, and having an iron case, in the center of which is the percussion arrangement. Besides the cartridge-case of coiled brass, there are others made of solid brass or copper (American invention), and these seem to be gaining favor abroad, the Prussians having adopted such a case for the new Mauser rifle.

For sporting rifles the cartridges are quite numerous and varied. With large-bore rifles the same cartridge-case is generally used as for shot-guns, but loaded with powder and ball (spherical, solid conical, hollow conical, or shell). For small-bore, or what are known as *express* rifles, either a coiled brass cartridge-case, similar in construction to that for the Snider or Martini-Henry rifle, but made to contain a larger charge, or a solid brass case is used. The coiled case can be reloaded twice or thrice, while the solid case can be reloaded as often as twenty times, and on this account the latter is rapidly gaining favor with sportsmen in India and Africa. The express cartridge contains a very heavy charge of powder, with a light hollow conical bullet giving very great velocity, low trajectory, and immense killing power. In the Henry express cartridge the charge of powder is 4 drams, while the bullet weighs only 270 grains.

Cartridges for breech-loading pistols and revolvers are generally small metal cylinders containing a charge of powder and a bullet, and with rim, pin, or central-fire ignition, the diameter varying from .230 of an inch upwards.

In the manufacture of metallic cartridges the United States leads the world. Besides the various patterns described under other headings in this work, the United States Cartridge Company, of Lowell, Mass., make a specialty of the central-fire solid-head reloading cartridges, of which some full-size varieties are shown in the drawings. This Company commenced operations in the year 1869, having for its object the manufacture of the Meigs solid-head metal upset by heading joined, rupture was liable to take place. These difficulties have been entirely overcome by the new method of manufacture; and since its introduction, and during the manufacture and trial of several millions, not one shell has been ruptured by firing, nor has a gun been impeded by any failure. During a remarkable test by the United States Navy Department, of firing 100,000 cartridges consecutively in the Gatling gun, not a single

Central-fire Solid-head Reloading Cartridges.—Rifle.

cartridge, which could not be burst or ruptured by any possible charge of powder, and which could be depended upon at all times for rapid firing in magazine, repeating, and ordinary guns. New and improved machinery, the result of extensive, exhaustive, and costly experiment, was erected. By the usual failure occurred which prevented the operation of the gun for a second, although 64,000 rounds were fired in a single day, without stopping to clean the gun.

This method of manufacture has been fully developed and perfected by this Company, and the cost is but little more than the usual one. This cartridge

Central-fire Solid-head Reloading Cartridges.—Pistol.

method of manufacture, good cartridges were made, yet when fired they frequently failed, bursting near the head, or around the body of the shell near the head, clogging the gun or endangering the user. After long and careful examination, study, and experiment, it was discovered that part of the metal of the shell at or near the head, as hardened by the usual process of drawing, was rendered brittle and completely demoralized by the then known process of heading, and when this hard-drawn metal and the is of the reloading type, and the method of priming has been brought to such great perfection that during the trial above referred to but two primers failed to explode in firing 100,000 rounds. During the experience of this Company very many of the great number of primers which have been introduced have been tested and abandoned, and not until the one now in use was invented was any primer found which could be relied upon under all conditions. In this primer the anvil is firmly secured directly in line with the firing-pin, and the fulminating-compound is fully protected from displacement and injury. The merits claimed for this cartridge are: great strength and non-liability to rupture; adaptability to reloading; ease of extraction; certainty of fire, and water-proof. See *Ammunition, Blank Cartridge, Center-fire Metallic-case Cartridge*, and *Reloading-cartridges*.

CARTRIDGE-BAGS.—Cartridge-bags are made of two shapes: conical, for gomer chambers, and cylindrical, for other ordnance. The cartridge-cloth from which the bags are made is woven expressly for the purpose, being entirely of wool, and of close and uniform texture. It is manufactured in pieces varying in width from sixteen to thirty-six inches; the different widths being adapted for the several lengths of cylinders to save waste in cutting. Cartridge-bags for cylindrical chambers are made of a rectangle to form the cylinder, and a circular piece to form the bottom. The flat patterns are consequently to be made rectangular for the cylindrical part of the bag, and circular for the bottom. The length of the rectangle is equal to the development of the cylinder, together with the allowance for seam; and its width, to the whole length of the bag before sewing, including the allowance for seam and tie. Special patterns are furnished for those of 15-inch, 11-inch, and 9-inch guns. Cartridge-bags for gomer-chambered ordnance are made conical in shape, and out of two pieces. In cutting, the length of the rectangle should be taken in the direction of the length of the stuff, as it does not stretch in that direction, and the material should be chosen, as nearly as possible, of the width required for the length of the bags, to save waste in cutting.

The cartridge-bags for field and mountain service are made as follows: A marker and assistant spread out the cloth on the table in two thicknesses, and make it fast at each end of the table on three or four hooks driven in the ends of the tables, or by means of weights, drawing it sufficiently to take out the folds, and no more. They mark out the rectangles and bottoms with the patterns and ruler, so disposing and combining them as to cut the cloth to the best advantage. The length of the rectangle (development of the cylinder) should be taken in the direction of the length of the stuff, as it does not stretch in that direction. The selvage, if there be any, ought to be at the mouth of the bag. The cutter takes a piece thus marked to another table, and cuts out the rectangles and bottoms with a pair of shears. The bottoms may be cut out with a hollow punch of the proper size. Marks for the seam are traced on the rectangles and bottoms by means of patterns of the proper size. The seam should be at least a half-inch from the edge. The bag is sewed with woolen yarn, with a back-stitch, 12 to the inch. The edges are turned down on the same side of the seam and basted, to prevent the powder from sifting through; the edges of the bottom are basted down upon the sides. Bags may be sewed advantageously by the sewing-machine. Bags for fixed ammunition are sewed to within three inches of the mouth for 12-pounders; all others up to the mouth. A bag is given as a model to sew by.

Cartridge-bags, when filled, should pass through the small shot-gauge of their caliber; those used for patterns should be thus verified. The empty bags should be measured by laying the bag, flattened out, between two marks on a table, showing the width of the pattern-bag; a variation of .1 inch greater or less is allowed. Those sewed with too large stitches are rejected.

Bags for practice or blank cartridges may be formed by sewing together two rectangular pieces with semicircular ends; the cloth is marked for cutting and sewing, with stamps made of 1-inch boards of the dimensions of the cutting-stamp, with a strip of tin or copper fastened to the edge of the board, and projecting about ¼ inch perpendicular to the side; another strip, parallel to the first, is inserted in a groove ½ inch from it; the edges of these strips are made rough to retain chalk or paint used in marking. A handle is placed in the middle of the face opposite to the marking-strips. Width of cutting-stamp for 12-pounder, 7.6 inches; length, including semicircular ends, for 12-pounder, 10.5 inches.

Cartridge-bags are preserved from moths by being packed with pounded camphor and black pepper, or dipped in water with arsenic dissolved in it, or a solution of sulphate of copper, 1 pound of sulphate to 25 pounds of water; or they may be sealed up in bundles of fifty in cases made of cartridge-paper, carefully closed with strips of thin paper pasted over the seams. Each bundle is marked with the number and kind of bags. They may be preserved from moisture by being enveloped in water-proof paper.

The charge of powder for siege and garrison guns is inclosed in a cartridge-bag made of merino, raw silk, serge, cotton, or paper, or of paper with woolen bottoms. Bags made of woolen or silk materials are preferable, as they are not so liable to leave fire in the guns, and are more durable; but they are much more costly. *Merino or cotton bags* are cut in two pieces, in the form of a rectangle, with semicircular ends, and sewed together to form the bag, as described in making bags for field-service.

The paper for *paper bags* is cut into rectangles to form the cylindrical part of the bag, the length of the rectangle being the development of the cylinder, allowing .5 inch on each side for the lap, and into circles for the bottoms. The sides of the rectangle are lapped and sewed with woolen yarn; one end of the bag is slit with longitudinal cuts, 1 inch long, .75 inch apart, and these strips are pasted on the paper bottom over a cylindrical form; or a circular piece of merino is sewed in the end of the paper bag, forming the bottom. To close a paper bag after being filled, the open end is folded down about .75 inch wide, and this fold is rolled on itself down to the powder, and the part which projects beyond the cylinder is turned in on the top of it. Two turns are taken with strong twine around the cartridge in the direction of its length, 90° apart, and then tied.

For mortars, cartridge-bags may be made in the same way as for guns, their dimensions corresponding to those of the chamber of the mortar. But as the charge is generally poured loose into the chamber, the bag being used only for carrying it to the mortar, a gun cartridge-bag of any convenient size may be used for mortar-service.

For ricochet firing, or other occasions when very small charges are required, a cartridge-bag for a piece of an inferior caliber may be used. Or else, after the charge is poured into the bag, place on it another bag filled with hay, pressing it with the hands to reduce the diameter; after having shaken this bag down and rolled and flattened the empty part of the two bags, tie them with woolen yarn, like a bundle of musket-cartridges, placing the knot on top.

For proving ordnance, cartridge-bags may be made of cotton cloth. They should be of the full diameter of the bore or chamber.

For hot-shot, cartridge-bags should be made double by putting one bag within another. The charge ought not to exceed three fourths the service-charge, for in consequence of the expansion of the shot the windage is reduced, and a greater strain will be exerted on the metal of the gun. The expansion of the gas will also be increased by the heat generated within the bore; and, moreover, very great penetration is not required, the object to be attained being that the shot shall merely lodge in the timber See *Ammunition*.

CARTRIDGE-BELT.—A belt for carrying small-arm cartridges. A form extensively used in the Western United States, called the *prairie-belt*, has a number of leather or canvas loops sewed on the outside in which the cartridges are stuck.

CARTRIDGE-BLOCK.—A contrivance for more readily supplying ammunition when firing rapidly or when it is not convenient to go to the cartridge-box for cartridges, in certain situations. Cartridge-blocks are usually made detachable, and are made fast to the piece when desirable. See *Benton*, *Hare*, and *Metcalfe Cartridge-blocks*.

CARTRIDGE-BOX.—A leathern case, with cells for cartridges, which are protected by a flap of leather. This box is either suspended by a leathern strap, which passes over the left shoulder and under the right arm of the wearer, or is attached to the waist-belt, as in the United States service.

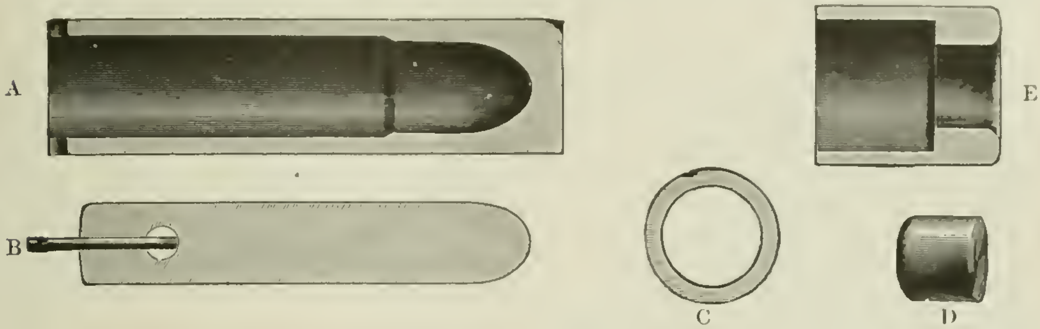
CARTRIDGE-GAUGES.—Gun-metal rings of the required size, with a handle to each gauge, on which is stamped the nature and size of the cartridge. There are two kinds: one for testing the diameter of the filled cartridge, the other for showing the length of the cartridge.

CARTRIDGE-LOADER.—An apparatus for loading cartridge-shells. The drawing represents a complete cartridge-loader, combining in one compact and portable machine all the various implements employed in loading paper or metallic shells, viz.: powder and shot reservoir and gauges, rammer, wad-starter, shell-cutter, and crimper.

This machine loads very quickly, and during the operation of loading the cartridges the powder is inclosed in a covered reservoir. The cartridges are loaded uniformly, and the wads squarely placed, thus improving the shooting of the gun. An adjustable shelf adapts the cartridge-receiver to loading shells of any length. The machine can be carried in a gun-case, occupying smaller space than the paraphernalia in general use. No practice is required to make it perfect in its use, and there are no complicated parts liable to get out of order. All the parts are in one, and the loss by the separation of any, and danger of breakage, are thus reduced to a minimum.

The accuracy with which the powder is measured will be best understood when it is stated that fifty charges being cut off in one tray of the most sensitive scale, and fifty in the other, no difference can be detected in the balance, the equipoise being perfectly preserved. The machine is not simply a combination of old parts, but embodies several new inventions. The device for cutting shells disposes of the rings which form upon all other knives to the inconvenience of the operator; and by the lever employed in crimping no lateral motion is imparted to the shell, and a shell only an inch in length can be closed or turned over if desired. See *Reloading Implements*.

CARTRIDGE-LOADING IMPLEMENTS.—The implements used in reloading cartridge-shells. These are variously constructed. A tool for *recapping* and *reloading*, of very light weight, manufactured by the United States Cartridge Company, has been used with much success both in our army and abroad. Its parts are shown in the drawing. A is the crimping-die and ball-seater, cut open; B is the cap-extractor;



Recapping and Reloading Tool.

C is the collar; D is the capping-punch; and E is the safety-block, cut open.

To cap the shell, place the collar upon it and insert the shell into the long die or ball-seater and crimper. Put the cap in the pocket by hand, then place the safety-block down over the shell and die. Put the capping-punch through the hole in the safety-block, the solid end resting upon the cap, and force the cap home by striking upon the end of the punch with the hammer. The convex surface on the capping-punch is for the purpose of forcing the cap *below* the surface of the head of the shell.

To load the shell, remove the safety-block and take the collar from the shell; fill the shell with the required amount of powder, drop a ball into the ball-seater, and place it over the shell. Then insert the head of the shell into the safety-block, taking care to remove the capping-punch from the hole in the block to prevent the premature discharge of the cartridge, and force the ball home by striking upon the end of the ball-seater with the hammer. At the same time the ball is driven home the end of the shell is crimped, and upon removal from the tools the cartridge is ready for use.

After firing the cartridge, to remove the exploded cap, place the head of the shell in the safety-block and insert the cap-extractor in the shell, the small pin will pass through the vent-hole in the shell, and a light blow will remove the cap. Should the loaded cartridge stick in the ball-seater, it can be easily started by inserting the pin in the end of the cap-extractor in the slot in the end of the ball-seater under the flange of the shell. As the collar is only necessary in recapping those shells that are crimped upon the ball, none are used with tools for shells that do not require crimping.

With all reloading tools for straight tapered shells a reducing-die is generally employed to restore the shell to its original size and shape. None are made for straight or bottle-necked cartridges. Moisten the shell slightly with oil, to prevent it from sticking in the die; enter the shell at the large end of the die; place the safety-block over the head of the shell, and drive the shell down into the die by striking on the end of the block with the hammer.

To extract the shell from the die, hold the die firmly in the hand with the head of the shell down; insert the hollow end of the extractor in the mouth of the shell, and strike several quick blows on the rounded end. To reduce the shell easily it will be necessary to let the end of the die rest upon a firm foundation. See *Reloading Cartridges*.

CARTRIDGE-PAPER.—A strong paper of which cartridges are made. It comes of various sizes and thicknesses, according to the kind of cartridge to be made, ranging from a quality similar to bank-note paper, employed for small-arm cartridges, to that used for cannon-cartridges, which is about the thickness of thin pasteboard, but rougher and more flexible. The latter is, however, now seldom or never used. The different qualities are in the United States service numbered from 1 to 6, the latter being the coarsest and thickest.

CARTRIDGE-PRIMER.—The percussion-cap used in loading metallic cartridge-cases, and set in a recess in the head of the shell. When the firing-pin strikes the outside end of the cap, the fulminate is exploded by being driven against a perforated cone called the anvil, which is usually a part of the shell. In the Winchester primer, recently invented, the anvil is a part of the primer itself, being inserted upon the fulminate. A shoulder in the recess holds the anvil when the cap is struck. The Frankford Arsenal cartridge-primer is designed and manufactured as a component of the solid-head reloading cartridge, which has a pocket, formed in the exterior of the base of the shell, to receive and securely hold the primer. It is essentially a revival of the percussion-cap, which served for many years as an adjunct to muzzle-loading small-arms, and now, modified in its

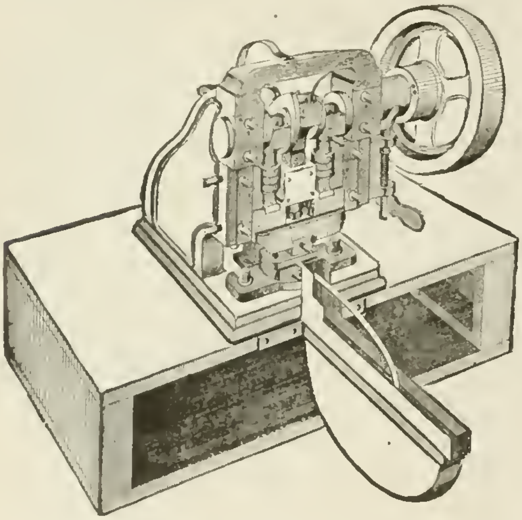


Fig. 1.

form, construction, and application, fills an equally important purpose in the modern breech-loader, being an integral part of the cartridge, instead of a detached auxiliary to the arm. It consists of a copper cap containing a pellet of fulminating-composition, protected by a disk of tinfoil, and a copper anvil, so formed as to permit the flame from the fulminating-composition to pass, through a vent in the pocket of the cartridge-shell, to the powder-charge, and at the same time afford resistance to the blow of the firing-pin of the arm, which explodes the fulminate. The primer-cap is formed, charged, and dried before the anvil is inserted. When the two are assembled the complete primer is ready for insertion in the pocket of the shell, prior to loading the latter with powder and bullet. The materials entering into its composition are as follows:

Materials.	Components.
Sheet cartridge copper......	Primer-cap.
Fulminating composition....	Primer-cap.
Tinfoil....................	Primer-cap.
Cartridge copper wire.......	Primer-anvil.

The sheet cartridge-copper is received from the manufacturers in the form of a ribbon, about 50 feet long, from .36 to .37 inch wide, and from .025 to .027 inch thick, coiled for automatic feeding to the machine which forms the caps. The blanks for the caps are cut from the sheet-metal ribbon as disks and formed into caps by a double-action press represented in Fig. 1, the disk being cut by a die and hollow punch, and pushed through the die to form a cap by another punch following it down through the hollow one. This machine is automatic, requiring attention only when a ribbon is cut up and is to be replaced with another. The skeleton or scrap ribbon is also cut into short pieces by the machine, to facilitate its packing and return as scrap to the manufacturer. The metal ribbon having been oiled to facilitate the formation of the caps, they must be washed in an alkaline solution to remove every trace of oil, which, if present, would destroy the fulminate. After washing and drying, the caps are varnished on the interior surface of the base, to protect the fulminate from injurious chemical action with the metal, and to assist in attaching and sealing it in place. A solution of gum shellac in alcohol, four pounds of the former to one gallon of the latter, constitutes the varnish used. The varnishing-machine (Fig. 2) consists of an iron bed-plate and two uprights, upon which a cross-

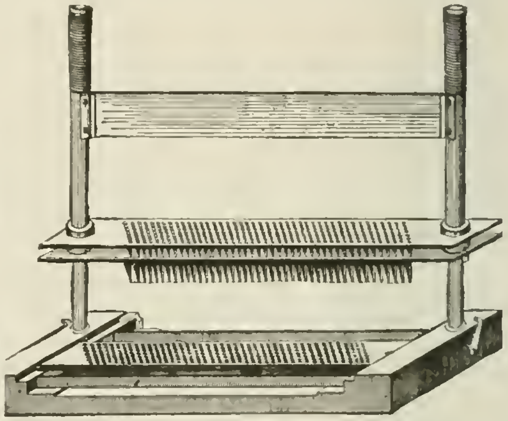


Fig. 2.

head, carrying a gang of wire pins, moves vertically over a vessel containing the varnish. Just above the varnish-pan the bed-plate is grooved to receive and adjust accurately, under the gang-pins, a plate containing the caps, in receptacles arranged in rows corresponding to the pins. The plate is filled by shaking it, with a handful of caps placed over the receptacles, with a horizontal motion. The caps settle into the receptacles, open end up generally, and the surplus caps are shaken off. The filled plate is inspected, and any caps requiring it are reversed by the aid of a forceps. The caps remain in the plate until they are charged, inspected, and ready for removal to the drying-room. A plate holds 326 caps, and a tally is kept of each plateful, to keep account of the number of caps completed. In varnishing, the ends of the pins are made to dip into the varnish by lowering the cross-head to a stop. When it is lifted each pin carries a drop of varnish. The plate of caps is pushed into the groove in the bed-plate, the cross-head is lowered until the pins touch the caps, and then raised, leaving a drop of varnish in each cap. The plate of caps is withdrawn and laid for a few minutes upon the heater, which consists of an iron plate heated by steam-pipes under it to a temperature of about 200° Fahrenheit, the object being to dry the varnish. The plate of caps is removed to the cooler, which is an iron plate cooled by contact with water on its under surface. By the reduction of their temperature the caps may be safely charged without further delay. The fulminate composition consists of—

Moist fulminate of mercury..	6	pounds.
Powdered chlorate of potash.	1.75	"
Ground glass crystals.......	1.66	"
Mucilage............	14	fluid ounces.

The preparation of the fulminate of mercury is prepared as usual, except that aquafortis of the same specific gravity is used instead of nitric acid, the former being the commercial nitric acid and less expensive. The ground glass is sifted between bolting-cloths of 100 and 160 meshes per linear inch, to remove coarser and finer particles. Owing to its liability to sour in warm weather, the mucilage should be made only in such quantities as can be used before it spoils. The moist fulminate is well drained of its water, spread upon a board, and rolled out into a thin sheet, like pastry. The dry chlorate of potash and glass-dust are spread evenly over and thoroughly incorporated with it, by means of a wooden rolling-pin and a spatula, using care not to allow any of it to become scattered and dry. The mucilage is next added, and the whole mass well stirred and mixed, after which it is placed in a delf bowl and the latter covered with a damp cloth. If too moist, it is left spread out a short time until it has the consistency of a stiff paste. The charging-machine consists of a rectangular iron bed-plate, 18 by 20 inches. At one edge is a groove to receive the plate of caps from the cooler. Near the inner edge of this groove a plate, perforated with holes corresponding to the caps, is hinged to the bed-plate, to measure and convey the charges to the caps. The tinfoil is procured in strips about 150 feet long, 2.25 inches wide, and from .003 to .0035 inch thick. It is cut into strips about 4 feet long for convenience in handling and feeding to the machine. This short strip is laid flat upon a table, and its upper surface is coated with shellac varnish, after which it is laid aside to dry. A number of strips having been thus prepared, one at a time is taken and again coated with a thinner shellac varnish immediately before feeding it to the foiling-machine. The last coat of varnish softens and combines with the first and facilitates the attachment of the edge of the tinfoil disk to the varnished surface of the bottom of the cap around the charge. The foiling-machine is a single-action press arranged to receive and move horizontally the plate of caps under a gang of punches and dies. The strip of foil is fed between these tools, and by them cut into disks. The caps are next shaken out of the plates into trays having woven brass-wire bottoms, in which they are removed to the drying-room (Fig. 3), where they remain for six or eight weeks. The room is kept at a temperature of about 100° Fahrenheit, and by suitable ventilation its atmosphere is kept in motion and gradually renewed. This process is necessary to dry and harden the charge. At first sight it would seem to impair the sealing between the tinfoil disk and the base of the cap, for that is the only avenue of escape for the moisture of the charge; but it is probable that the temperature slowly dries the charge and keeps the varnish soft enough to renew the sealing at such points where it may be temporarily opened by the escaping moisture. A comparison of the water-proof quality of caps dried in this slow manner and more rapidly, at higher temperature, shows a decided advantage for the former method. Although they are not absolutely water-proof, they are sufficiently so for the ordinary vicissitudes of service, and the risks of serious accidents attending the use of dry fulminate, for the sake of hermetical sealing, are obviated. The primer-anvil is made from cartridge copper wire, which is procured in coils about 50 feet long, for automatic feeding to the machine which forms the anvil. The anvils are cut from this wire by a punch and die operated by a single-action press (Fig. 4), after which they are washed to free them from oil, dried, and churned in clean hard sawdust to brighten them and remove any burr formed in the operation of cutting them from the wire. This machine is automatic, requiring attention only when a new coil of wire is needed to supply it, and it cuts the skeleton wire or scrap into small pieces for convenience in packing and shipment to the manufacturers. The anvils and caps are assembled by means of a lever hand-press. They are shaken into receptacles in plates prepared for each. These fit together by dowel-pins, and a plate having pins corresponding to the anvils forces them, by aid of the press, securely into the caps. The complete primers are now ready for insertion into the pocket of the shell, or for being packed, for issue separately, in tin seamless boxes containing 500 primers each. After its insertion in the shell a drop of varnish is put upon the primer, *in situ*, by a machine similar to that for varnishing the caps. This varnish flows around the junction of the primer and pocket, and renders the cartridge practically waterproof. See *Center-primed Metallic-case Cartridge*, *Charging-machine*, and *Foiling-machine*.

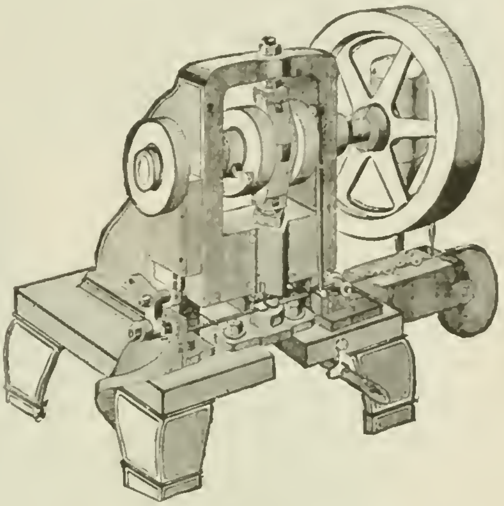


Fig. 4.

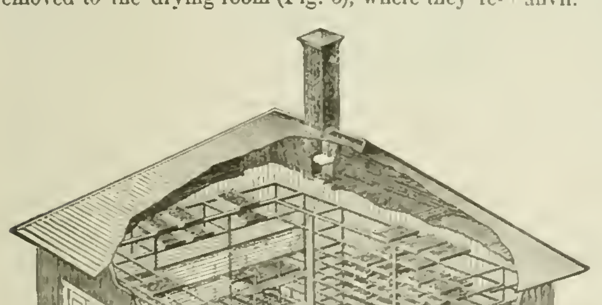
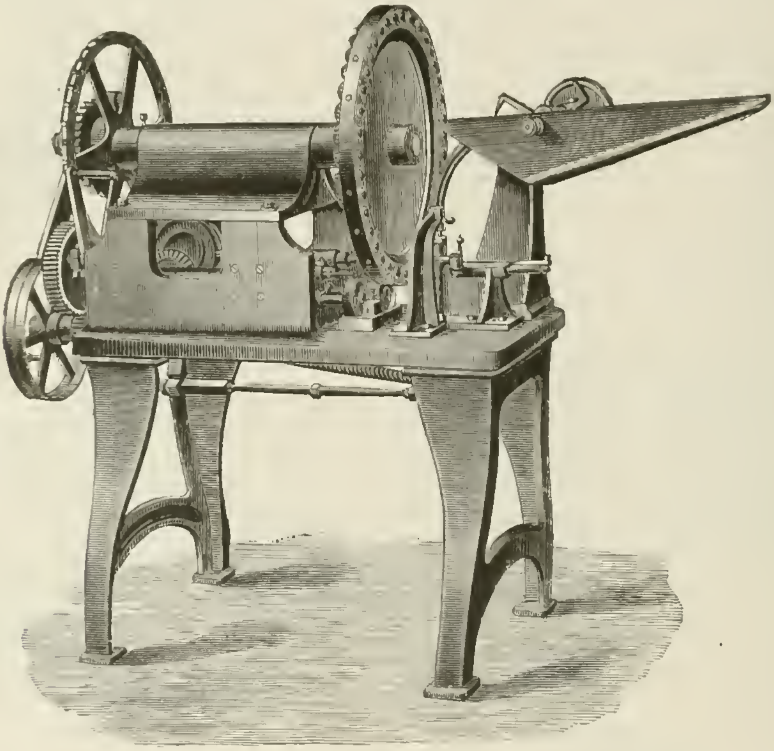


Fig. 3.

CARTRIDGE-RETRACTOR.—That part of a breech-loading fire-arm which catches the empty cartridge-case by its flange and draws it rearwardly from the bore of the gun.

CARTRIDGE-VARNISHING MACHINE.—The design of this machine is to coat the interior of metallic rifle-shells with air impermeable elastic varnish that will prevent chemical action between the salts of the gunpowder and the material of the shells. The result is to insure the preservation of the shells, and of the quality of the cartridges, for an indefinite period. The operation is also adapted to the preparation of once-discharged shells, making them available for recharging. The shells are placed in a hopper, several hundred at a time, and fed singly, 40 passing through the different stages of the process at once, at the rate of 2000 or more per hour. Besides revolving around the central spindle, the shells are rotated in the chucks which hold them, to prevent the accumulation of the varnish in any one spot, and to insure its being spread evenly. This rotary motion "sets" the varnish, which should afterwards be hardened and thoroughly dried, by means of a cheap sheet-iron furnace, that may be readily heated by steam-pipes, or in any other convenient manner. One operator may attend two or three machines, as all the motions of the machine are entirely automatic, including an effective stop-motion, that acts promptly at any obstruction. To insure uniform results, the temperature of the room in which the machine is used should be kept, as nearly as possible, at 70° Fahr., and the air should be dry and free from dust. The machine may be adapted to shells of any caliber. It weighs 1800 pounds.



Cartridge-varnishing Machine.

CARTRIDGE-WIRE.—1. The priming-wire whereby the cartridge is connected to the conducting-wire of the voltaic battery. 2. The needle whereby the cartridge-envelope is pierced, in order that the priming may connect with the powder.

CASCABEL—CASCABLE.—The projection in rear of the breech. It is composed of the knob and the neck; the latter unites the knob to the base of the breech. In heavy guns of recent model the cascabel is quite rudimentary, while in mortars it is entirely wanting. The object of the cascabel is to facilitate handling the piece when mounting, dismounting, and transporting it. The *cascabels* of ships' guns have *breeching-loops* in place of knobs, intended for the *breeching*, whose ends pass to ring-bolts on each side of the port, and whose duty is to limit the recoil.

CASCABEL-BLOCK.—A device employed in the inspection of cannon. It consists of a wooden cylinder of the proper diameter of the breeching-hole, the size of which it is used to verify. The opening between the jaws may be ascertained by measuring the iron block which is fitted to go between them, or by a template. See *Inspection of Ordnance.*

CASCABEL-PLATE.—In machine guns, a plate closing the rear end of the breech-casing, and serving to incase and protect the revolving-gear. See *Gatling Gun.*

CASCANS.—In fortification, holes in the form of wells, serving as entrances to galleries, or giving vent to the enemy's mines.

CASCHETTO.—An Italian casque of the sixteenth century, in iron beaten work, chased and also damascened.

CASE.—1. The charge-holder of a submarine mine. Whatever may be its form, the following conditions are essential:

1st. It must be water-tight, to prevent damage to the charge by leakage.

2d. It must be sufficiently strong to bear handling without danger of becoming leaky by straining, and must be able to sustain the external pressure due to the depth of water at which it is to be placed.

3d. When gunpowder, or gun-cotton fired with an ordinary fuse, is used, it must be sufficiently strong to hold the charge together, as it were, for an instant at the moment of ignition, so that its full effect may be obtained by as thorough a combustion as possible of the charge.

4th. In the case of a buoyant mine, it must be capable of being arranged with a large excess of flotation, so that when moored it may remain as stationary as possible at the required point.

5th. It should be of such form as to be capable of being handled and moored conveniently.

6th. It should be of such form as to secure the thorough ignition of the charge with the smallest possible number of fuses.

7th. It should be easy of construction and not too costly.

First, with reference to the form of the case. This generally is either conical, spherical, or cylindrical. The former is the best for self-acting buoyant mines. The apex (Fig. 1) of the cone forms a convenient point to which the mooring-cable may be attached, while the base, terminating by a curved portion, serves as an air-chamber, giving the necessary buoyancy to keep the mooring-cables taut, and to hold the mine in a comparatively stationary position in a current or tide-way. The nipples containing the fulminating composition are placed on the rim uniting the base with the conical surface. In this position they are most likely to be struck by a passing vessel. There should be four or more of these nipples, depending upon the size of the case. For all other cases, except the one just mentioned of a floating mine, intended for small charges to be exploded by mechanical means, the cylindrical form is best, and the one most frequently adopted for both ground and buoyant mines containing heavy charges. Fig. 2 represents the form so successfully used by the Confederates, 1861–65. Fig. 3 represents that of the Austrians. For large ground-mines the best form of case seems to be that of the turtle-mine. A heavy charge may be contained in it; it forms its own anchor, and it would withstand an explosion of an adjacent mine without sustaining any injury. This is the best form for resisting strong currents. The difficulty and cost of making spherical cases have heretofore debarred their adoption on a large scale, but recently General Abbott, U. S. Engineers, has simplified the process of manufacture and made them practicable. This process consists in pressing circular disks of steel into hemispherical segments, which are united by flanges, as represented in Fig. 4. As regards the material of which the cases may be most advantageously constructed, several substances have been tried and used, such as wood, iron, and vulcanized India rubber. For actual war-service, regularly-constructed torpedoes or mines would generally be turned over to the posts ready for use; but it might become necessary to improvise cases out of such materials as would be available. Tight barrels and hogsheads, when properly strengthened, are a good substitute for even the most improved form of case. The barrel or cask is simply an external shield for the protection of the charge, which is contained in a water-tight envelope, and may be an India-rubber bag or a tin or zinc can. The strengthening of the cask is to guard against collapsing when submerged in deep water. Under ordinary circumstances the depth of the water will not be so great as to require strengthening of good casks beyond stout hoops of iron. As the charge must generally remain a considerable time—perhaps many months—under water before explosion, it is most essential to have the case, whatever it may be, completely water-tight; and with this view the cask is coated, both inside and outside, with a composition of pitch and tar. The envelope containing the charge within the cask should be firmly fixed, so that no independent motion may disturb the connections of the electrical apparatus. See *Submarine Mines.*

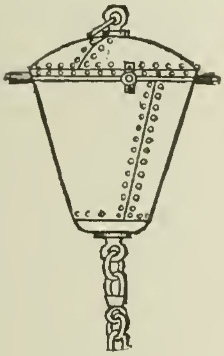


FIG. 1.

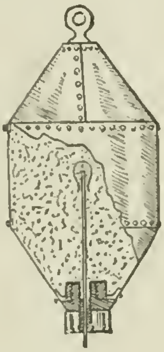


FIG. 2.

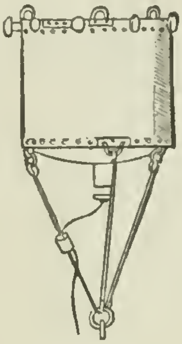


FIG. 3.

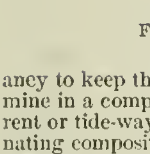
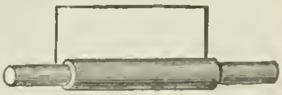


FIG. 4.

2. To give a portable form to compositions, they are inclosed in cases, cast in molds, or attached to cotton yarn, rope, etc. Cases are generally paper tubes, made by covering one side of a sheet of paper with paste or gum-arabic, then wrapping it around a *former*, and rolling it under a flat surface until all the layers adhere to each other.



The quality of the paper, and the thickness of the sides of the case, should depend upon the pressure of the gases evolved in the burning. To fill a case, it is first cut to the proper length, and placed in a mold; the composition is then poured in, a ladleful at a time, and each ladleful is packed by striking a certain number of blows on a drift with a mallet of a given weight. The height of each ladleful of composition should be about equal to a single diameter of the bore of the case. Small drifts, receiving heavy blows, should be made of steel, and tipped with bronze; large drifts may be made of wood or bronze, depending on the force of the blow. In driving highly inflammable compositions, as that of the rocket, care should be taken to settle the drift, so as to exclude the air before striking with the mallet, as the heat generated by the sudden condensation of air might be sufficient to ignite the composition. Preliminary tests of all new materials should be made by burning one or more specimens of the composition, and the proportions of the ingredients corrected, if necessary. The length of the flame from a given composition depends on the size of the vent and the extent of the burning surface. The vent is made small by *choking* the end of the case with stout twine; and the burning surface is increased by driving the composition around a spindle, which on being withdrawn leaves a conical-shaped cavity. A vent may be also formed by driving in moist plaster of Paris or clay, and boring a hole in it with a gimlet. If the end of the case is to be closed up entirely, the boring is omitted. See *Compositions* and *Fuse.*

CASE-HARDENING.—A process by which the external surface of wrought-iron is converted into steel to enable it to resist the wear and tear of friction and to receive a fine polish. It produces the external hardness of steel without its brittleness. Case-hardening consists in heating the wrought-iron to a cherry-red in a close vessel in contact with animal-charcoal, and then plunging the heated iron into cold water or sperm-oil. Bone-dust is usually employed at the armory, although old shoes, leather scraps, hoofs and horns of animals, and soot may be used. The bones are first pulverized and then charred. The work to be case-hardened is packed as follows: First, a layer of animal charcoal or bone-dust is placed over the bottom of the iron retort, and then rows of the iron pieces to be case-hardened are placed side by side, but not in contact, until the stratum of bone-dust is covered. Enough bone-dust is now put in to cover the metal parts, and then another layer of components put in as before. Continue to put in these alternate layers until the retort is full; and lastly, pour a quantity of the finest bone-dust on the top of the retort, and pack it down well to exclude the air. The retorts thus packed are transferred to an oven or reverberatory furnace and brought to the proper heat, when they are removed and plunged into cold water or sperm-oil, where they are left until cold. The process is called *case-hardening in oil* or *case-hardening in water*, according as sperm-oil or water be used for the cooling medium. If plunged in oil the metal is uniformly *blackened* on the exterior, provided the air does not strike it and produce a film of oxide, which will "scale" off and leave a marred surface. When water is used the "steeled" surface will often exhibit fine colors, and will be harder than that chilled in oil. The iron will be more liable to crack ("check"), especially at sharp angles, and to warp by sudden and unequal contraction when immersed in water than it would in oil. In packing, the small parts are frequently strung together on wires for convenience in handling. See *Fabrication of Fire-arms*.

CASEMATE.—Various modes have, from time to time, been proposed for arranging defensive casemates for the exterior defense of land-fronts. The difficulty in covering the masonry from the batteries of the assailant has been the chief objection to these structures, and is the more prominent as the fire of artillery becomes more accurate, as such casemates would soon be ruined or rendered untenable by embrasure shots. The structure for this purpose which has been most applied within late years is what is termed the *Haxo casemate;* the details having been first proposed by General Haxo, one of the first authorities of the French school of engineers. These casemates consist of a series of arched bomb-proof chambers closed in front by a thin mask wall which, except around the embrasures through it, is covered from the assailant's artillery by the parapet. To present but a small surface of masonry to fire, the arches, which are horizontal and perpendicular to the mask wall for the greater portion of their length, descend toward the front, leaving where they join the mask wall just sufficient height within for the service of the gun. To effect this the anterior portion of the arch must be conoidal in shape. The piers of the arches are pierced with wide arched openings, which serve the double purpose of a communication between the casemates and to give the gun a wider traverse for firing. Embrasures are pierced in the parapet in prolongation of those of the mask wall, and it is proposed to cover the small portion of the masonry necessarily exposed by this arrangement by placing several thicknesses of heavy timber in front of it to receive the shot, or to case it with wrought-iron. When the casemates serve simply for the cover of the cannon, the arches are covered with from 4 to 6 feet thickness of earth, and are left open to the rear for the more prompt escape of the smoke, and a ditch is sometimes made just in rear of the casemates to catch bombs and limit the effects of their explosion. When the arches are made longer than for the service of the guns alone, the earthen covering is sometimes arranged with a parapet to cover cannon in the barbette, or for small-arms.

In the casemated batteries for sea-coast and harbor defenses, the scarp or mask walls of the chambers for the guns, being exposed to the fire of ships alone, are not covered, as on land-fronts, by an earthen mask; these walls being built of sufficient thickness and strength to withstand the fire of the heaviest guns within the range that ships can venture to attack, and being far less vulnerable than the wooden or iron sides of vessels thus far brought into general use. These batteries in our own and European works consist of a series of arched bomb-proof chambers which serve for the service of the guns alone; or else they receive such dimensions that the portions of the chambers immediately in rear of the mask wall are appropriated to the service of the battery, and the rear portions are converted into quarters, store-rooms, and other necessary purposes for the garrison. In the earlier sea-coast casemated defenses constructed in our service, the gun-chambers have received dimensions to admit of two guns in each chamber. The chambers are usually formed of segmental brick arches of 120°, which rest upon stone piers built back perpendicular to the mask wall. When the casemates serve also as quarters for the garrison, the rear, towards the parade, is closed by a brick or stone parade-wall, which forms the front wall of the quarters. A brick partition-wall separates the quarters from the gun-gallery. Arched recesses and flues are made in the piers for chimneys, and the parade-wall, the sides of the piers, and soffit of the arch are suitably finished to give a dry and well-ventilated dwelling. In most of our earlier casemated works there is but one tier of casemated guns; this tier being surmounted by a barbette battery covered either by an earthen or stone parapet on the water-fronts. Casemates adapted to two guns in each room present a more vulnerable mark in the portion of the mask wall between the piers; expose more men to danger from embrasure shots; present a greater opening in rear to the assailant's fire when not closed by a parade-wall; offer less resistance to the shock of shells; and are more difficult to construct without settling than rooms for single guns. These advantages in favor of casemates for single guns are the more marked where, for the purpose of obtaining a heavy fire in some fixed direction, it is desirable to resort to a castellated structure consisting of several tiers of casemates. See *Covered Defenses* and *Mortar Casemates*.

CASEMATED RETRENCHMENTS.— Fortifications proposed by Carnot. They consist of a wall 36 feet high and 9 feet thick, erected at the gorge of the bastions, and provided with two rows of loop-holes, the upper for musketry, the lower for small mortars of a peculiar description. Behind this wall is a ditch 20 feet wide, and on the rear of it stands a casemated battery.

CASEMATE-GIN.—The garrison and casemate gins differ from the siege-gin in having two cross-bars of iron instead of the three wooden cross-bars, and in having the pry-pole inserted between the legs, which are kept together by the clevis-bolt. The upper block (generally treble) is hooked to the clevis. The casemate-gin is made shorter than the garrison-gin, so that it may be hoisted in casemates. With the guns now usually mounted in casemates it is essential to use a bail for slinging, in order to gain the necessary distance from the head of the gin for the working of the tackle. The gin is put together across the piece, or on the ground near it, and raised by moving up the legs and pry-pole towards each other. The pry-pole has cleats nailed to it to enable a man to mount to the head of the gin to hook on the block and to reeve the fall.

To reeve the fall, fasten one end of a trace-rope to the upper block by passing it through the *shell* of the block. An expert man ascends the pry-pole to the head, and passes the free end of the rope through the clevis, from whence it is carried down to the windlass, where a couple of turns are taken. By heaving on the windlass, the block is raised and the hook passed through the clevis, with its point *towards* the pole. The upper block may be hooked to the clevis and raised with the gin; the fall may also be rove and the whole raised together. The extra weight thus given makes the gin more difficult to lift. The gin is lowered by gradually drawing out the pry-pole until the men can get near enough toward the head to support it; it is then lowered upon the piece or on the ground, as the case may be. See *Gin* and *Mechanical Maneuvers.*

CASEMATE-GUN.—A gun mounted in a casemated battery. Casemated batteries are generally used on the sea-faces of works, and in defending the entrance of harbors, in which case they consist of a bomb-proof arch, open to the rear. Iron plating and shields of various thickness are used in the protection of the embrasures.

CASEMATES NOUVELLES.—Arched batteries which are constructed under all the openings of revetments or ramparts. The different forts of Cherbourg are defended by these casemates; the works erected around Dover Castle come likewise under this description; the works at Fort Columbus, New York, are erected on the same principle.

CASEMATE-TRUCK.—This machine is intended for moving pieces and their carriages in the galleries of casemate-batteries, or through posterns. It consists—old pattern, of a stout frame of wood; new pattern, of wrought-iron, mounted on three low wheels. Two of the wheels are placed at the sides, like those of a cart; the third is placed in a fork at the middle of the front end; the fork turns around its vertical axis as the direction of the truck changes. The fork and wheel are removed by raising the end of the truck and allowing the fork to drop from its socket. A tongue, likewise removable, is attached for the purpose of guiding the truck. To better understand the use of this construction, we will notice the manner of placing a casemate chassis on the truck.

The chassis is on the ground, the truck near it, with its front wheel and tongue removed. The chassis, either side down, is raised, by successive purchases, with handspikes, and blocked up to a height sufficient to allow the truck to go under it. The truck is then run under the chassis and turned so that

its axis is parallel to that of the chassis, and is so placed that the center of gravity of the chassis is, as near as possible, over the axle of the truck. The blocking is then removed and the chassis allowed to rest on the truck. The tongue of the truck is replaced. The truck is moved to the designated casemate, and the chassis lowered from the truck as it was placed thereon. If it is upside down, it is turned over and placed properly on the traverse-circles. The tongue of the chassis is then bolted to the front transom and secured by the pintle in the throat of the embrasure. The chassis may be lowered from the truck by means of the gin.

To remove the chassis from the casemate, the tongue of the chassis is unbolted from the front transom and the chassis raised, either by prying and blocking or with the gin; the truck is then placed under it as before. It is generally preferable to remove the front wheel from the truck and to pry up but one end of the chassis; the truck is then worked under it from the side, and, after the chassis is lowered upon the truck, the raised end is borne down until the front wheel of the truck can be replaced. See *Mechanical Maneuvers.*

CASERNES.—In fortification, buildings for the soldiers of the garrison to live in; generally erected between the houses of fortified towns and the rampart. In a general acceptation, casernes signify barracks.

CASE-SHOT.—An assemblage of bullets or small balls inclosed in a cylindrical case or canister. The diameter of this canister is a little less than the bore of the gun from which it is to be discharged. According to the size of the canister, the balls vary from 1 pound to ½ ounce each, from 30 to 280 in number, and from 3½ pounds to 85 pounds in total weight. The canister bursts immediately on leaving the gun, and the balls spread out into an irregular sort of cone. Within a range of 500 yards they work great execution among troops. They are generally used at 200 or 300 yards.

In a more modern and effective kind, called *Spherical Case*, the bullets are inclosed, along with a charge of powder, in an iron shell, instead of a tin canister. It is often called *Shrapnel*, from the name of its inventor. A spherical case-shot for a 68-pound carronade, or for an 8-inch howitzer, contains 337 balls; for a 24-pounder gun, 128; and for an 18-pounder, 90. It is exploded by a fuse the length of which depends on the distance of the point where the destructive effect is to be wrought. Its effect is something like that of a prolonged musket-fire. The Shrapnel shell is not of much use against the hull of a ship, but is very destructive against masses of men on shore, or on the decks of a ship, with a greater range than that of ordinary canister. Artillerymen prefer just such an amount of charge as will burst the sphere, without scattering the balls very widely. See *Canister-shot*, *Grape-shot*, *Projectiles*, *Shells*, *Shrapnel*, and *Spherical Case-shot.*

CASHIERING.—A punishment for officers in the army and navy. It is a severe form of dismissal from the service, and implies that the officer, by some disgraceful conduct, has deserved not only dismissal, but disqualification for ever again entering the service. Sometimes there are words added implying still deeper ignominy and degradation. On some rare occasions, when a Court-Martial has awarded cashiering, the Commander-in-Chief has mitigated the punishment to simple dismissal. "Scandalous and infamous conduct," and "Conduct unbecoming the character of an officer and a gentleman," mark two degrees of offense which may lead, the one to cashiering, the other to dismissal.

CASING.—1. The middle wall of a blast-furnace. Beginning from the inside, we find the *lining*, *stuffing*, *casing*, and *mantle*. 2. A wooden tunnel for powder-hose in blasting. 3. The cast-iron case of converted guns.

CASK.—A round wooden vessel of more length than breadth, bulging out in the middle, and closed up at either end. In military operations casks are used to form bridges across rivers when no pontons can be had. They should be about 4 feet 3 inches long, and diameter at head and bulge 2 feet 2 inches and 2 feet 9 inches respectively, which is the size of the water-butts of the navy; but any barrels available will answer. Casks filled with earth may also be used as gabions on an emergency, and also in the erection of barricades when it is necessary to build a revetment.

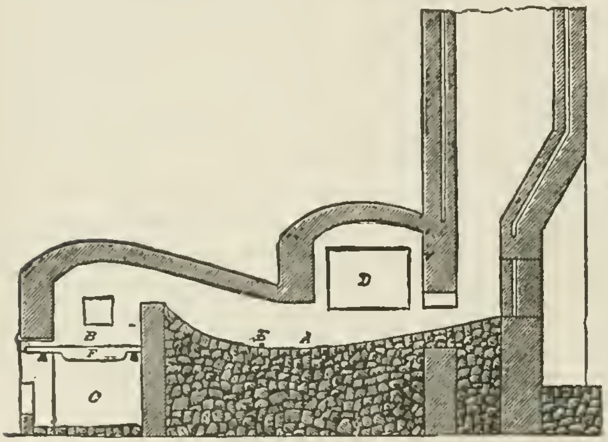
CASQUE.—The French name for helmet, and which in ancient armor was the name by which that head-piece was known. Also written *Cask.*

CASSE-TETE.—A mace or war-club, made of very hard wood, used formerly in savage warfare.

CASSINE.—A small house, especially in the open country; applied also to a house standing alone, where soldiers may lie hid, or may take a position.

CASTELLAN.—A Governor or Constable of a castle. The office and the rank of the Castellan were various in various countries. In France and Flanders the title Castellan belonged to the holders of certain demesnes, and was next in order of rank to that of a Bailiff. In Germany the Castellan had the jurisdiction of a Burg-graf during the Ages of Chivalry. In Poland, the title of Castellan, with its appendages, remained in later times, and, after the sixteenth century, the Castellans, with the Waiwodes and Bishops, formed the Senate or Superior Legislative Chamber.

CASTING.—The operation next after *molding*, in the fabrication of cast guns. The metal for the gun is melted in reverberatory air-furnaces, of the construction shown in the drawing, two or three being sometimes required for casting the heavier guns. In these furnaces the draught is produced by high chimneys instead of a blast, which is used in the cupola-furnace. The metal for what is termed a "heat" is all placed in the metal-chamber, A, before the fire is lighted. The fuel, bituminous coal, is placed on grate-bars, F, in the fuel-chamber, B, and, when ignited, the flame passes through the metal-chamber on its way to the chimney. The iron is melted by this flame without coming in contact with solid carbon at all, unlike the cupola-furnace, where the fuel and iron are mixed together. D is the charging-door, and C the ash-pit. The furnace is prepared for charging by covering the bed of the metal-chamber with a layer of sand evenly distributed and firmly packed. Boards



Reverberatory Air-furnace.

are laid down, upon which the pigs of iron are piled. If a number of guns are to be cast from the same grades of iron, it is very important that the beds of the furnaces should be prepared in every instance as with the standard gun, as the treatment of a given charge of iron may be varied by the manner of dressing the bed of the furnace. The different grades of iron to be used for the heat are weighed and piled in proper proportions in the metal-chamber. Care should be taken to have the furnace perfectly dry throughout. When it has been out of use long enough to become damp, it should be dried by a fire in the fire-chamber before being charged. When two or more furnaces are used in casting a gun, the tap-holes, E, are connected by troughs with a reservoir called a mixing-basin, in which the different charges are thoroughly mixed before entering the mold. The furnaces being charged and everything in readiness, the fires are started and regulated so that the iron in all will be melted or "down," as near as practicable, at the same time. The length of time required to obtain complete fusion depends in great measure upon the state of the atmosphere and quantity of metal in the charge; it may vary from 5 to 12 hours. When the charge is nearly down, wooden poles or iron rods are inserted in holes provided for that purpose in the walls of the furnaces, and the melted metal frequently stirred or puddled to bring the unmelted lumps in contact with the flame. As soon as the charge of a furnace is ascertained to be fairly down, specimens are taken out to determine whether the iron is sufficiently decarbonized or "high" to be in a proper condition for casting. These specimens are cast in green sand-molds and broken as soon as they become cold. The condition of the iron is indicated by the appearance of the fracture, and varies so much with different brands used that its determination is largely a matter of experience. If the first specimens show insufficient decarbonization, the iron is kept in fusion still longer and the puddling process is continued. When it is found that the decarbonization has gone far enough, the puddling is stopped. As the density and tensile strength of the iron depend in a great measure upon the highness to which it is brought, a correct decision is very important. As soon as the melted metal in all the furnaces is found to be in proper condition for casting, the furnaces are tapped simultaneously and the metal conducted by troughs to the mixing-basin, where the several charges are thoroughly mixed. It then flows on through other troughs connecting with the side-gates of the mold, and, passing down, enters the mold-cavity by the branches. These branches connect with the side-gates at regular intervals, and are so constructed that the metal enters in a horizontal direction toward the axis of the mold-cavity. The surface of the metal, as it enters, is stirred to prevent the scoria from lodging; care should be taken not to give it a "swirl," which throws the lightest metal in around the core, where the heaviest and best should be. When the mold is filled, the tap-holes of the furnaces are closed, and the surface of the metal in the sinking-head is covered with a layer of charcoal to prevent its chilling. For two or three hours after the casting, more metal is added at short intervals of time, to feed the shrinkage, by pouring from a ladle at the top of the mold as the surface sinks. See *Rodman Gun.*

CASTING-LADLE.—An iron vessel with handles for conveying molten metal from the cupola and pouring it into the mold. The term is also applied to a ladle used in the manufacture of steel, made of wrought-iron lined with fire-clay, having a small hole in the botton for running out the melted steel into the ingot-molds placed below. This hole is closed by an iron rod coated with fire-clay, and is raised or lowered by a hand-lever. The ladle is mounted on trunnions on the arm of a hydraulic crane, which allows it to be brought over the molds in the pit.

CASTING OUT.—The rejection of horses deemed unfit for further cavalry use. Usually written *Casting.*

CAST-IRON.—By refining, etc., a portion of the carbon and other impurities may be removed, but so long as the proportion of the carbon is not less than 2 per cent the metal will possess the characteristic properties of cast-iron mentioned below. The presence of silicon, sulphur, and phosphorus modifies the strength, brittleness, etc., of cast-iron very much, that of sulphur in particular increasing its tenacity, which is always, however, comparatively low. We may say that cast-iron contains from 2 per cent to 5 per cent by weight of carbon, which exists in two states, either chemically combined with the iron or mechanically mixed with it. In the trade, cast-iron is distinguished by numbers from one to eight, the lower numbers being given to those descriptions in which the surface when broken presents a gray or mottled appearance, and in which the larger part of the carbon is in the state of graphite—that is, uncombined with the iron. The higher numbers represent white or bright iron, and in these the carbon is almost entirely in the combined state. Cast-iron is easily fused, and can be readily cast into a homogeneous mass of any size or shape we choose, but it is brittle and cannot be worked under the hammer either hot or cold. If, indeed, we heat a mass of cast-iron to a red heat and hammer it, it will crumble to pieces—a fact taken advantage of in the breaking up of obsolete smooth-bore cast-iron guns.

The following table shows the mean mechanical properties of American cast-iron employed in rifle-guns of large caliber, as determined by the tests of a trial cylinder, 60 inches long with an elliptical base 24 inches by 19.5 inches.

Original Dimensions of Specimens.	Nature of Property.		
	Density		7.2771
Area, 1,001 square inches	Tenacity per square inch		33,875
	Hardness		18.46
	Hardness of copper		3.33
Length, 30 inches; diameter, 1.385 inch; area, 1.5065 inch.	Pulling stress per square inch:		
	Elastic limit	pounds	9,750
	Ultimate resistance	do.	31,000
	Ratio of elastic limit to ultimate resistance	per cent	31.45
	Extension per inch at elastic limit	inch	0.00051
	Ultimate extension per inch	do.	0.00337
	Ultimate restoration per inch	do.	0.00199
	Ultimate set per inch	do.	0.00163
	Reduction in area at point of rupture	per cent	0.215
	Ultimate resistance per square inch fractured area	pounds	31,065
	Appearance of fracture: bright gray medium-sized crystals.		
Length, 10 inches; diameter, 1.385 inch; area, 1.5065 inch.	Thrusting stress per square inch:		
	Elastic limit	pounds	8,200
	Compression per inch at elastic limit	inch	0.00093
	Compression per inch under 43,000 pounds	do.	0.00619
	Restoration per inch under 43,000 pounds	do.	0.00344
	Set per inch under 43,000 pounds	do.	0.00275
	Increase in area of cross-section after 43,000 pounds	per cent	0.371
Length, 2 inches; diameter, .8 inch	Absolute resistance to crushing force	pounds	114,143
	Bending stress:		
Length, 20 inches; breadth, 1.075 inch; depth, 1.075 inch	Transverse resistance	do.	11,556
	Bursting stress:		
Cylinder: length, 5 inches; exterior diameter, 3 inches; interior diameter, 1 inch.	Ultimate resistance	do.	63,184

See *Gray Cast-iron*, *Manganese*, *Mottled Cast-iron*, *Phosphorus*, *Silicon*, and *White Cast-iron*.

CAST-IRON GUNS.—It is in the smelting-furnace that the character of the iron is fixed. Iron of good character and high susceptibility may be spoiled by treatment at the foundry; but this, with ordinary experience and intelligence, ought but rarely to occur. But from iron that leaves the smelting-furnace with bad qualities it is impracticable, with our present knowledge, to make good and reliable guns. The smelting of iron is a purely chemical process, and should be conducted with the same regularity and precision as any other important chemical process. Though, with every precaution, perfect uniformity in the quality of the iron produced from day to day cannot be expected, in consequence of the many disturbing causes which tend to affect its character, yet a near approximation to it is practicable. All the stock for a "blast" of gun-iron should be carefully prepared and housed before beginning to "blow." The ore should all be roasted and well mixed so as to be as nearly uniform, as to size of lumps and all other qualities, as possible. The charcoal should all be made as nearly as possible from the same kind of wood, and well mixed together after charring. All the stock should be carefully weighed and supplied to the furnace at regular intervals of time. The pressure, temperature, and hygrometrical condition of the "blast" should be kept as nearly constant as possible. The temperature of the blast may be kept very nearly constant without using what is termed a "hot blast," by warming it just enough to bring it above the highest summer temperature. The quantity of moisture may, it is believed, be kept nearly constant by passing the blast some distance over water heated to the proper temperature. And this may be readily done by passing the blast through a long horizontal tube, like a cylindrical steam-boiler, partly filled with water, and kept at a constant temperature by the waste heat from the furnace. The temperature of the water should be such as to saturate the blast with moisture, and thus render it hygrometrically independent of atmospheric changes.

Supposing a standard of quality to have been determined, with the stock all prepared for a given number of guns, and having determined by comparison with the *standard* the quality of iron required, a further approximation to identity in quality of the metal in the guns may be made by casting each run of metal from the smelting-furnace into a number of pigs of equal size, something greater than the number of guns to be made, and piling them in separate piles—each run of metal furnishing one pig to each pile. Each pile should contain iron enough for one gun and one test-cylinder, and be kept separate and distinct from all others in transportation, and be repiled in the foundry-yard in the same order as at the smelting-furnace; one gun being made from each pile, after the treatment which the iron should receive at the foundry shall have been determined by experiments made on the iron in the surplus piles. The pigs should be cast in molds prepared from a pattern, so as to be as smooth and free from adhering sand as possible. The quality of the iron is much modified, and ordinarily improved, by remelting and long continuance in fusion. But all kinds of iron are not affected in like manner by the process. The difference between the iron as it exists when presented for use, and as it exists in the body of the finished gun, is very great, and has been found to be, in certain cases, more than twenty pounds per cubic foot in density, and in tenacity as 1 to 2.8. This shows how unreliable the tests of the pig-iron are, as means for determining the quality of iron and its suitableness for making cannon. It is found that, though some kinds of iron are susceptible of very great improvement by different methods of treatment at the foundries, other kinds are at their maximum strength in the crude pigs. The cause of this difference in the susceptibility for change and improvement will doubtless be found in the qualities of ores used, and in the process of melting them.

In examining the effects of the different treatment of iron at the foundry, such samples should be chosen as will best exhibit the following particulars and characteristics, viz.: 1st. The properties which distinguish the different grades of iron made from the same ores at the same furnace. 2d. The changes in the mechanical properties of iron produced by repeated meltings of one of these grades, separately, showing the changes effected at each melting. 3d. The changes produced by repeated meltings of the different grades of iron mixed. 4th. The changes produced in iron of the same melting and quality by casting it into masses of different bulk, and by different methods of cooling. The softest kinds of iron will endure a greater number of meltings with advantage than the higher grades. It appears from experiments with Greenwood iron, that when it is in its best condition for casting into proof-bars of small bulk, it is then in a state which requires an additional fusion to bring it up to its best condition for casting into the massive bulk of cannon. In selecting and preparing for cannon, we may proceed by repeated fusion, or by varying the proportions of the different grades and different fusions until the maximum tenacity is attained. An increase of density is a consequence which invariably follows the rapid cooling of cast-iron, and, as a general rule, the tenacity is increased by the same means. The density and tenacity usually vary in the same order. It appears that the tenacity generally increases quite uniformly with the density, until the latter ascends to some given point; after which an increased density is accompanied by a diminished tenacity. The turning-point of density at which the best qualities of gun-iron attain their maximum tenacity appears to be about 7.30. At this point of density, or near it, whether in proof-bars or gun-heads, the tenacity is greatest. As the density of iron is increased its liquidity when melted is diminished. This causes it to congeal quickly, and to form cavities in the interior of the castings. If in preparing iron for guns it is carried *too high*, either by long continuance in fusion or by using a large portion of a hard grade of iron, the casting will be lost.

The following table exhibits the various qualities of cannon-metals:

Metals.		Density.	Tenacity.	Transverse str'gth.	Compressive str'gth.	Hardness.
Cast-iron	least....	6.900	9,000	5,000	84,529	4.57
	greatest	7.400	45,970	11,500	174,120	33.51
Wro'ght-iron	least...	7.704	38,027	6,500	40,000	10.45
	greatest	7.858	74,592	....	127,720	13.14
Bronze.......	least....	7.978	17,698	....	....	4.57
	greatest	8.953	56,786	....	....	5.94
Cast-steel....	least...	7.729	....	....	198,944	.....
	greatest	7.862	128,000	23,000	391,985	......

A prominent feature of this table is that which shows the great difference between the lower and higher grades of the same metal. In cast-iron the density differs as 6.9 to 7.4, a difference equal to 31 pounds per cubic foot; in tenacity it differs as 45,970 to 9000 pounds per square inch, or as 5 to 1; and in hardness as 7 to 1. The bronze varies in tenacity from 56,786 to 17,698, more than 3 to 1; and in density it is as 8.953 to 7.978, equal to 61 pounds in the cubic foot.

While the cannon are making, the inspecting officer examines and tests the metal before it is used, observes its melting and casting, and tests the metal in the first gun made before the second is cast. If the first proves unsatisfactory, such changes are made, either in the material or in the treatment, as will tend to produce the desired result. This practice of ascertaining the quality of the material used, and of the casting made from day to day, as the work proceeds, enables the founder to distinguish the material, to select those of the best quality, and to treat them in the best manner. If these tests are satisfactory, the inspecting officer is assured of the good quality of the guns before any proof by firing is made. And this supersedes the necessity of using excessive proof-charges in the final proof, which may do serious and fatal injury to guns without bursting them or leaving any visible marks of injury. The testing instrument furnishes to the founder a convenient and accurate method of comparing the qualities of iron. It therefore enables him to select his materials before casting with greater certainty and safety. He can also by these means determine the comparative utility of different methods of melting and casting the gun. As the quality of the iron is essentially changed by the different ways of treating it while in the melted state, and by the different means adopted for cooling it after it is cast into the mold, the testing instrument enables one to ascertain the effect produced by these processes in all their several stages of progress, and to decide upon that which is found most suitable for making the guns of the best quality.

Of the various circumstances which affect the strength of cannon-metal, the most important appear to be those which connect themselves with crystallization. The size of the crystals of a particular metal depends on the rate of cooling of the heated mass; the most rapid cooling giving the smallest crystals. The size of the crystals or coarseness of grain in castings of iron depends for any given *make* of iron and given mass of castings upon—first—the high temperature of the fluid iron above that just necessary to its fusion, which influences—second—the time that the molten mass takes to cool down and assume again the solid state. The lower the temperature at which the fluid iron is poured into the mold, and the more rapidly the mass can be cooled down to solidification, the closer will be the grain of the metal, the smaller its crystals, the fewer and least injurious the planes of weakness, and the greater the specific gravity of the castings. Slow cooling develops a coarse, uneven grain, with large but thoroughly irregular and confused crystallization: cast-iron with such a grain is never strong or cohesive, though soft and extensible. The more rapidly a casting once consolidated can be cooled, without introducing injurious effects, the finer, closer, and more even will be its grain on fracture, and with any given metal the greater will be its strength. The rate of cooling cannot be accelerated beyond a moderate limit. If this limit be exceeded, as by casting in a cold, thick, highly-conducting metallic mold, the iron is "chilled," its constitution changed, and the carbon, not having time to crystallize out, remains combined or diffused through the mass. It should not be so fast as to cause unequal contraction, nor must it be so fast in large castings, such as guns requiring to be "fed" from a *feeding* or *sinking head* with fresh portions of hot fluid metal during consolidation to fill up the internal cavities or porosity due to contraction and crystallization, that this filling cannot be accomplished. The larger the mass of the casting, with any given quality of iron, generally the coarser is the grain—that is, the larger are the crystals that develop themselves in the mass. The same metal that shall produce a fracture bright gray, mottled, and without a crystal visible, in a small bar, will in a large casting produce a dark, confusedly crystalline surface of fracture as coarse as granite rock. A certain amount of contraction, on becoming solid from the liquid state, occurs in all castings. For iron this is variable and depends upon the mass of the castings, being greatest for small and least for large castings, of the same make of iron, and poured at the same temperature. There are two conditions that principally affect the degree of contraction, namely, the extent to which the fluid metal as entering the mold has been expanded by elevation of temperature, and the state of final aggregation of the particles, depending upon the size of the mass. Sudden changes of form or of dimensions in the parts of cast guns, besides the injury they do to the crystalline structure of the mass, introduce violent strains, due to the unequal contraction of the adjoining parts whose final contraction has been different. The enormous time required by a large casting for cooling is not generally known. A solid casting sufficiently large for a 15-inch gun weighs about 35 tons; it is red hot three days after having been cast, and only becomes cold enough to handle after a fortnight. The cooling of a casting must be uniform so far as uniformity is possible. This is impossible strictly in any casting; the approach to it is most difficult in heavy solid castings, and hence the great advantage of the practice of hollow casting upon a suitably made core admitting of internal cooling by artificial means. The contraction of cast-iron in becoming solid introduces strains into the mass by consolidation of one portion of the casting before another. When a large gun is cast solid and the metal cools in the ordinary way, the external portions solidify long before the interior has ceased to be liquid, and the process of solidification is propagated, as it were, in parallel layers from the outside to the center of the mass. When the first layer or thickness of solid crust has formed on the exterior it forms a complete arch all round, so that the contraction between fluidity and solidification of each subsequent layer is accommodated by portions of matter withdrawn radially from the interior towards the still cooling exterior—that is to say, from a smaller towards a larger circumference. The final effect of this propagated to the center of the mass is twofold: first, to produce a violent state of internal tension in the particles of the metal in radial lines from the axis of the gun inward as a cylinder, tending to tear away the external portions of the mass from the internal nucleus; second, to produce about the center or along the axis a line of weakness, and one in which the texture of the metal is soft, porous, and of extremely low specific gravity. The effect of this unequal contraction may be so great as to crack the interior metal of cast-iron cannon, even before it has been subjected to the force of gunpowder, and large masses of iron which have been cooled very rapidly by casting them in iron molds have been known to split open longitudinally from no other cause than the enormous strains to which they are subjected.

Guns have long been cast in a vertical position and with a certain amount of head of metal above the topmost part of the gun itself. From this head the casting is fed with fresh portions of fluid metal during consolidation; it also affords a gathering-place for all scoria or other foreign matter. But the great value of increased head of metal is in adding to the density of castings and so also to their strength. Fineness of grain, smallness of crystal, density, increased cohesion, and elasticity are all induced by casting under largely increased statical heads of fluid metal.

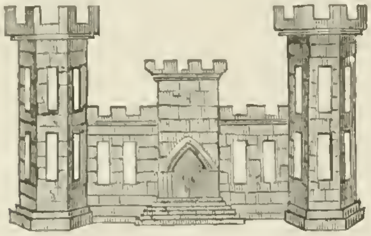
In the practical treatment of iron in fusion while preparing it for casting into cannon, it may be safely continued in fusion, with increasing improvement of its quality, so long as sufficient liquidity is retained to insure an exemption from cavities in the interior of the casting. The point at which such cavities of a fatal character will form will be reached before arriving at the point of density for maximum tenacity. A convenient method for determining the condition of the iron while in fusion, and whether it has arrived at the proper condition before casting or should be longer continued in fusion, is found in dipping from the melted pool of iron and casting into small bars, about 10 inches long, and from 1 to 2 inches square at one end and tapering to a point at the other end. The first one is taken from the furnace, and cast soon after the iron is all melted, and others are cast at such intervals afterwards as may be judged proper. They are cast vertically, point downwards, in sand-molds, and cooled rapidly. Proof-bars are cast at different times while the metal is in fusion. They are broken in different places, and the condition of the iron is judged by the appearance of the several fractures. These fractures will exhibit various aspects, from white at the small end to dark gray at the large end: and the bars cast at the latter periods of the fusion will exhibit the white at a greater distance from the small end, and the mottle, bright and lighter shades, will be found advancing towards the large end. This method, although much less reliable than that of an actual measure of density and strength, is convenient because of its ready application at short intervals, while the iron is in fusion, and a practiced eye will soon be able to mark the progress of the changing quality of the iron, and to determine the proper time for casting the gun. In process of time, a gradual adjustment of the internal strains produced in cooling cast pieces takes place; like many other substances, iron possesses the property of accommodating itself to this.

The principal improvement in the fabrication of cast-iron guns is General Rodman's process of cooling them as far as possible from the interior, and for this purpose casting them hollow. The design is to remedy the various defects of the old process; principally to obviate the tendency of solid castings to burst by their own initial strains, by reversing the process of cooling and shrinking described above. Since there would then be no force opposed to the contraction of the inner layers of metal, except the trifling cohesion of the liquid or pasty mass that they shrink away from, they would not be left in tension, and therefore they could not exert any power to pull the exterior layers into compression. The method employed is to carry off the internal heat by passing a stream of water through a hollow core, inserted in the center of the mold-cavity before casting, and to surround the flask with a mass of burning coals to prevent too rapid radiation from the exterior. Extensive trials have been made to test the merits of this plan, and the results show that cast-iron cannon made by it are not only stronger but are less liable to enlargement of the bore from continual firing, the surface of the bore being the hardest and densest part of the casting, and best calculated to resist pressure and abrasion.

Before proceeding to manufacture cannon in quantity, a *trial-gun* may be made and exposed to extreme proof with *service*-charges. After undergoing this proof in a satisfactory manner, the trial-gun should serve as a standard, and the proportions of the several kinds of metal used, and the methods employed in the manufacture, should be followed in all respects in the fabrication of other guns.

With the trial-gun should be cast a *sample-gun*, or a cylinder of equal diameter, and at least half the length of the gun, from which test specimens should be cut and tested. The sample-gun or cylinder should be of the same diameter as the guns to be made, and should be made under the same circumstances which are to attend the preparation of the iron for, and the casting and cooling of, the guns themselves. The object of the sample is to obtain specimens which have not been subjected to previous strain and vibration, as would be the case if taken from the fragments of the broken trial-gun. For it is impossible to reason back to what would have been either the capacity for work, or work due to elasticity of an unstrained specimen, by knowing to what extent these properties were possessed by that specimen after it had been subjected to both strains and vibrations of unknown intensity and number. And although it is interesting to know to what extent these properties are possessed by the fragments of a worn-out gun, yet it would be of far greater practical utility and importance to know the value of these properties in the new, untried guns. Specimens thus obtained would afford reliable results, and in connection with the powder-proof, with service-charges of guns cast at the same heat, these results would become standards. See *Crystallization*, *Fifteen-inch Gun*, *Ordnance*, and *Rodman Gun*.

CASTLE.—1. The insignia of the United States Engineer Corps, as represented in the drawing. 2. A building constructed for the purpose of repelling attack. The *castella*, left by the Romans in Britain and elsewhere, were constructed on the general model of their stationary encampments (*castra stativa*); and though they may have suggested the castles of the Middle Ages, they differed from them in being designed for military purposes only, and not also as places of permanent residence. Even Burgh Castle, in Suffolk, the ancient Garamenium, and Richborough Castle, in Kent, the ancient Rutupiæ, were encampments or fortresses, rather than castles. Besides these monuments of the military occupation of the island by the Romans, traces are found in various parts of the country of encampments or castles, which are ascribed to its aboriginal or early inhabitants. These are generally situated on the tops of hills; as, for example, the Herefordshire Beacon, on the Malvern Hills; Moel Arthur, in Flintshire; Chem Castle, in Cornwall; the Maiden Castle, in Dorsetshire; the Caterthuns, near Brechin, in Forfarshire; the Barmkin of Echt, in Aberdeenshire. It is probable that the Saxons adapted the Roman castles to a certain extent to their modes of defense, and traces of Saxon and even Norman workmanship are found in structures which are believed to have been originally Roman. One very frequent change consisted in raising a mound of earth on one side of the walls on which the keep or citadel was erected. The Decuman and Prætorian gates were also, as at Portchester, converted into the fortified entrances peculiar to the castellated structures of the Middle Ages. But of castles designed for residence as well as defense there are few or none which are of higher antiquity than the Conquest. They were part of the organization of the feudal system—castle-guard being one of the duties which the tenants were bound to pay in return for their lands; and till that system



Insignia of U. S. Engineer Corps.

was developed by the Normans, the residences of persons of importance were probably guarded only by their domestic retainers, or, in extraordinary circumstances, perhaps by the national militia.

The Norman castle was generally surrounded by a moat or ditch; and in order that the ditch might be readily filled with water, the site chosen was usually either on the banks of a river, or on a peninsula running into a lake. In the latter case the ditch was of course merely a deep cut made through the neck of land, by means of which the castle and its surroundings were converted into an island. On the inner side of the ditch mounds were constructed, which were surmounted with walls and towers, both of which, but particularly the latter, were supplied with battlements and bastions. The entrance-gates were also protected by towers, which were usually of great strength. The communication was by a bridge, sometimes of stone, but usually of wood, which was made to draw up and down; and the entrance, in addition to thick folding-doors, was protected by a portcullis, which was dropped down through grooves in the masonry at the sides. The gateway, in castles of the larger sort, was further defended by a barbican. On passing the external wall, you entered the bailey, which sometimes consisted of several courts, and contained the barracks, magazines, a well, a chapel, and sometimes even a monastery. The only portion of the castle which was always spoken of as distinguished from the bailey was the keep or citadel, which corresponded to the prætorium of the Roman fortification. The keep was a species of internal castle, more strongly defended than any other portion of the fortress, and placed in the most advantageous position, so as to afford a last chance to the garrison when driven from the external works. As the keep had the same design as the castle itself, it contained most of its appliances, even to a chapel, when large and complete. The keep was also called the dungeon or donjon. An excellent example of a keep is seen at Rochester Castle. The best known is probably that at Windsor, which forms so prominent an object in the surrounding landscape. The protection which the walls of his castle afforded to the retainers of a baron in a state of society in which life and property were extremely insecure naturally led to the construction of houses around the moat, and to this custom a very large number of the towns, both in England and on the Continent of Europe, owe their origin. See *Fortification*, *Keep*, and *Safety-redoubt*.

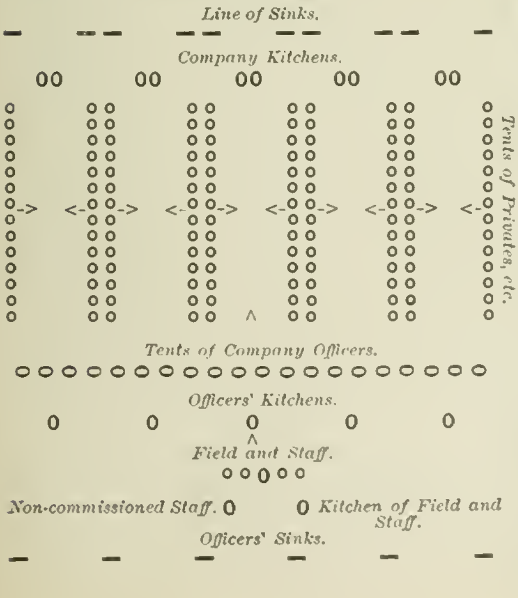
CASTLES.—In Heraldry, castles are often given as charges in the shields of persons who have reduced them, or who have been the first to mount their walls in an assault.

CASTRAMETATION.—The art of laying out camps and of placing the troops so that the different arms of the service shall afford support to each other in the best manner. A locality well sheltered and secured, and affording fuel, grass, and fresh water, should be selected for the camp. If it is expected to remain in the camp for any great length of time, its sanitary condition must be carefully observed. All ponds, swamps, lands recently stripped of their timber, and muddy rivers must be kept at a distance. In a malarious district it is well to habitually sleep between two fires. The flood-level of the nearest water should also be carefully noticed—weeds and stray bits of driftwood washed into the branches of adjacent trees or bushes will serve as a guide. Many streams are subject to sudden and terrific rises, and frequently without any apparent cause. When camping for the night on a fordable stream, with the intention of crossing, make it an invariable rule to cross it before going into camp. A sudden rise or appearance of the enemy might seriously interfere with the crossing next morning. Wind-storms are a common annoyance in the camp. When there is time to prepare for their coming, the tent-pegs should be secured and sufficient guy-ropes attached to the tent. If the soil is loose and sandy, rocks or other hard material should be placed under the tent-poles to prevent their working into the soil, and leaving the tent slack and unsteady; the pegs should also be inclined towards the tent, and driven in the direction of the prolongation of the tent-cords (if they are inclined from the tent they will soon be jerked loose). When the pegs will not hold at all, fasten the tent-cords to brush or rocks buried in the soil. A few trees add very much to the comfort of a camp, and when they are so situated as to permit the guy or ridge ropes to be made fast to them or their branches, the wind-storm need not be dreaded.

So far as may be prudent, the camp should be protected by bluffs and thickets, and the backs of the tents should be braced from towards the wind. It is not proper to camp beneath certain trees, whose branches are liable to suddenly fall off. In a hostile country the security of the command will depend very much upon the judicious selection of a camp as regards its capability of defense. If on the bank of a stream, a concave bend, where the water is very deep, should be selected. In such a position the defending party can cross his fire in case of an attack from the other bank, or can herd the stock in the concavity of the bend in order to avoid a stampede. When the camp is remote from a stream or river, a portion of it should rest on the highest hill or bluff within range. As a rule the tents should be pitched on that side of the camp most exposed to attack. When the packs and aparejos are removed in camp, they should be arranged so as to form a fortification in case of need. Immediately upon going into camp, pickets should be posted in strong positions, and sufficiently close to the camp to give timely alarm in case of the enemy's approach. The picket should be posted, during daylight, on some eminence near the camp, where he can keep a lookout in all directions. During the night he should be posted several hundred yards farther in advance of the point subject to attack and on *low ground*, in order that he may be screened from observation, and at the same time see to the best advantage, as low objects will then appear high and stand in bold relief against the sky; moreover, in timber it is easy to see a great distance between the trunks of the trees, while their tops and branches hide all objects beyond. If the picket discovers the enemy and is not seen himself, he should quickly withdraw and report the facts in order that no time may be lost in preparing for action. But if the picket is discovered by the enemy, he should first discharge his piece and then retreat. To save time and avoid all false alarms, a well-defined system of night and day signals should be devised, before going into the hostile country, and thoroughly understood by every picket. In this way they could very readily and promptly communicate their discoveries to the camp.

No rules can be laid down for laying out camps that will be universal. The proper exercise of the art of encamping is to so place the troops that they can quickly form line of battle on the position they are to occupy. In the United States, troops on campaign are provided with the shelter-tent, the pieces of which are carried by the occupants. In the presence of the enemy the troops bivouac in line of battle; if safety permits, the tents may be pitched immediately in rear of the line of stacks, the tents of the Company Officers in rear of their companies, the tents of the Field and Staff in rear of the center of the line of Company Officers. When not in the presence of the enemy, each battalion usually camps in column of divisions. The tents of each division are arranged in two lines facing each other; those of the right company face to the rear, those of the left company face to the front. The Company Officers' tents are arranged in line parallel to the flank of the column, facing the division-streets; the tent of the Captain of the right company of each division is to the right (or left) of the line passing through the center of the street, according as the officers are on the right (or left) flank of the column, his Lieutenants are on his right (or left); the Captain of the left company is on the left (or right) of the Captain of the right company, the Lieutenants of his company on his left (or right). The First Sergeant's tent is on the flank of the company towards the officers' tents. The tents of the Field and Staff, when practicable, are in line parallel to those of the Company Officers; the Colonel is opposite the center of the column, Lieutenant-colonel and Major are on his right, the Adjutant is on the left of the Colonel; the other Staff Officers are on the left of the Adjutant. The tents of the Non-commissioned Staff are in rear of the tents of the Staff; they may be assigned to tents in the divisions.

Camp of a Regiment of Infantry in Column of Divisions.



The kitchens of the men are in line on the flank opposite the Company Officers; the sinks for the men are outside of the line of kitchens. The kitchens of the officers are in rear of their tents; the sinks for the officers are in rear of the line of tents of the Field and Staff. The positions of the color-line, guard-tents, sutlers' store, officers' horses, and baggage-wagons are prescribed by the Colonel. The width of the division-streets, and the street in front of the Company Officers, varies with the nature of the ground and the strength of the battalion. When the companies are large, the camp may be formed according to the above principles, in column of companies, the tents of each company being in one line, or in two lines facing each other.

A battalion of Cavalry being in line with the usual intervals, to encamp, the men dismount, and, without forming rank, unsaddle and place their arms and equipments in line ten yards in front of the horses; the blanket is placed on the equipment, moist side up. The picket-line is stretched between posts about six feet high, or is stretched on the ground, the ends being firmly secured; the horses are tied to the picket-line by the halter at intervals of a yard; if the picket-line be on the ground, they may be fastened to it by a strap about two and a half feet long, the strap being provided with a collar which is buckled around the pastern of the left fore-foot. The tents of the men are pitched in line about fifteen yards in front of the picket-line, the intervals between companies being left free; the tent of the First Sergeant is on the right; the arms and equipments are kept in the tents of the men. The kitchens of the men are in line in front of their tents; the sinks in front of the line of kitchens. The tents of the Company Officers are in line about thirty yards in rear of the picket-line, the Captain on the right; their kitchens are in rear of their tents.

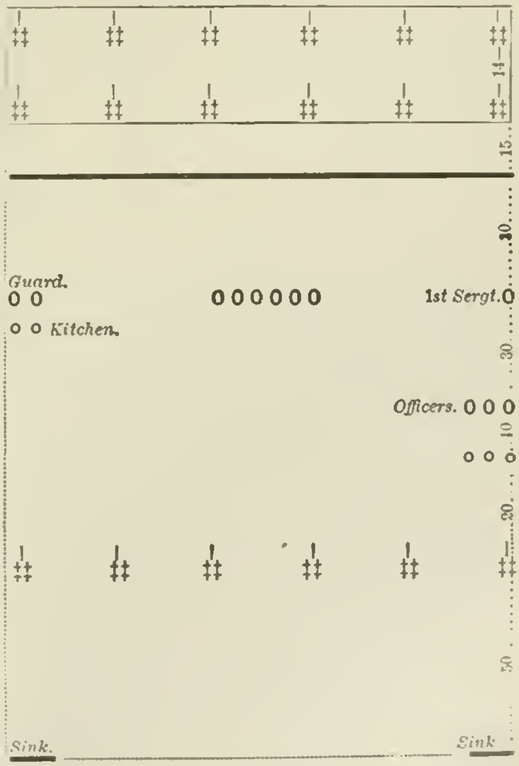


Fig. 1.

When Artillery camp, the pieces and caissons are parked at fourteen yards' interval, as shown in Fig. 1. The harness of the team of each carriage is on a rack on the right, and close to the carriage, so that the paulin can cover the harness. Horse-equipments are kept on the racks or in the tents. The picket-line is fifteen yards in rear of the caissons; it is stretched between posts about six feet high, the ends being firmly secured; the horses are tied to the picket-line by the halter at intervals of a yard. The men's tents are pitched in line about thirty yards in rear of the picket-line; the First Sergeant's tent covers the carriages of the right section; the left guard-tent covers the carriages of the left section; the tents of each section are in the order of their pieces in park, and are closed on the center, or to the right, so as to have a vacant space between the guard-tents and the tents of the left section. The men's kitchens are in line ten yards in rear of the guard-tents, which may be faced to the right so that No. 1 can overlook the kitchen. The officers' tents are in line thirty yards in rear of the battery-tents; the Captain's tent is on the right, covering that of the First Sergeant. The officers' kitchens are ten yards in rear of their tents. The battery-wagon, baggage-wagons, and forge are in line thirty yards in rear of the officers' tents; the battery-wagon covers the Captain's tent; tho forge covers the left guard-tent. The sinks are fifty yards in rear of the wagons; the officers' sink on the right, the men's sinks on the left.

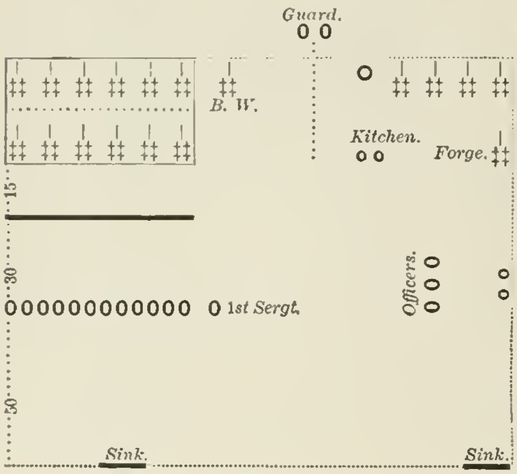


Fig. 2.

The preceding order may be modified as shown in Fig. 2, if circumstances require it. The battery-wagon and baggage-wagons may be in line with the pieces, the interval between the battery-wagon and nearest piece being fourteen yards, that between the battery-wagon and left baggage-wagon about thirty yards; the guard-tents half-way between the battery-wagon and baggage-wagons, facing to the rear; the forage-pile between the guard-tents and the baggage-wagons; the forge in line with the caissons and covering the right baggage-wagon; the men's kitchens in line with the caissons, and covering the left baggage-wagon; the officer's tents on a line perpendicular to the men's tents, facing them, and on the prolongation of one of the baggage-wagons; the officers' kitchen in rear of the officers' tents, and on the prolongation of the forge. In a *horse-battery*, if but one picket-line be used, it may be turned equally to the front around the flanks of the park; the battery-wagon, forge, and baggage-wagons may be divided equally and placed on the flanks of the men's tents, facing inward, and so as to be on the prolongation of the bent portions of the picket-line. The picket-line may also be in one straight line, in which case the baggage-wagons should be equally divided upon lines to the rear of its extremities. The horses are sometimes picketed in two lines, in which case the second line is fourteen yards in rear of the first, and the wagons are placed in line thirty yards in rear of the men's tents. See *Camp*.

CASTRIOTTO SYSTEM OF FORTIFICATION.—In this system the bastions are replaced by round towers, and the enceinte is covered by detached bastions. Vauban borrowed his second and third systems from Castriotto. He recommended demi-revetments and also hollow revetments. See *Fortification*.

CAST-STEEL.—This term until lately was confined to steel made by melting blister-steel, obtained by the old cementation process. Through this simple operation of melting it in crucibles, which was invented by an Englishman named Huntsman about the middle of last century, steel was first readily made perfectly homogeneous, and fitted for the production of the finer kinds of tools and cutting instruments. The crucibles are made of fire-clay, mixed with a small proportion of the material of old ones and coke. They are very carefully prepared and annealed, but notwithstanding this the heat of the furnace is so high that they can only be three times used. Each crucible contains from 30 to 40 lbs. of steel, which is poured, when melted, into cast-iron ingot-molds previously smoked. The name "cast-steel," however, can no longer be confined to steel so made, because Bessemer steel, although produced by a quite different process, is truly a cast-steel. In Sheffield the finer kinds of cast-steel are now sometimes called "crucible-steel;" but since puddled steel, which, like the Bessemer, cannot be used for fine cutlery, is also cast in crucibles, such a term is not sufficiently distinctive. See *Bessemer Steel, Crucible-steel, Puddled Steel*, and *Steel*.

CAST-STEEL GUNS.—In the fabrication of these guns, the best quality steel is cast into ingots 4 feet long and 15 inches square; the ingots are heated and hammered down till they are about 7 inches square, and long enough for two guns. The ends are hammered round, and a square block is left in the middle for the breech-mechanism, and two smaller blocks for the trunnions, presenting the shape shown in the drawing. The ingot is cut in halves at A, thus form-

ing the blocks for two guns. The gun-block is bored to a diameter of 2.5 inches, heated to a red heat and immersed in an oil-bath to temper it. After being tempered, it is turned and bored to a diameter of 2.92 inches and finally rifled, the grooves being .04 inch deep. The rimbases are planed to the proper dimensions, and the trunnions are screwed into them. Toward the bottom of the bore, and immediately in rear of the full rifling, is found the "shot-chamber." When the shot-chamber is reached, however, the ribs are cut away by a slope toward the rear, having an inclination of .04 of an inch, the depth of the rib, in 2 inches of length. This incline is called the compression-slope, it receives the belt of the projectile (when loaded), and centers the latter while in the loading position and as it is being driven into the bore. To the rear of this compression-slope the chamber continues on at a somewhat quicker inclination, connecting the shot-chamber with the powder-chamber. The latter is also a truncated cone, and has a diameter at the forward end of 3.2 inches, and at the rear end of 3.25 inches where the ring-recess is placed. The ring-recess is a short cylinder .39 of an inch long. It contains the Broadwell ring, or gas-check. Immediately in rear of the ring-recess is the screw-box. It has a female screw chased upon its surface, the thread having the same profile and pitch as that upon the breech-plug. Three blanks are planed longitudinally through the thread, each one removing one sixth of the surface. One blank is at the lowest side of the screw-box, and the other two equidistant from the first around the interior surface.

BALISTA, CATAPULTS, AND OTHER MODES OF ROMAN WARFARE. 1. Legionary. 2. Triarius. 3. Velitor[illegible] 4. Slinger. 5. Centurion. 6. Tribune of war. 7. Lictors. 8. Consul 9. Roman cavalry. 10. Plan of battle of the cohorts. 11. Roman encampment for five legions. 12. Plan of companies drawn [illegible]vable tower. 14. Balista (stone-thrower). 15. Battering-ram. 16. Battle-chariot. 17, 18 Catapults.

The plug, which is a cylindrical piece of steel, has a thread cut upon it. One half of the bearing surface of the plug-thread is cut away, in the same manner as has already been described for the screw-box, and the area thus to be removed is distributed into three longitudinal blanks, cut at equal intervals around the engaging surface. Thus there are on the plug, and also in the screw-box, three sections of screw-threads, separated by blanks, running parallel to an element of the bore, forming a slotted screw. In order to lock or secure the plug into the rear of the bore, it is only necessary to match its threaded sections to the blanks of the screw-box, and to push the plug at once home. A turn to the right of one sixth of the circle then engages, at the same time, all the threads of the plug with those of the screw-box; after which the plug is ready to oppose the effort of the charge. In rear of the threaded sections the plug is plain, where it works circumferentially in the collar, and it is terminated at the rear end by a flange, having its forward side furnished with locking-faces, the use of which will be explained elsewhere. The rear end of the plug is deeply recessed, in order to obtain lightness; the forward end is terminated by a flat face, which is recessed in the center to receive the boss of the nose-plate. The plug is also pierced with an axial hole one inch in diameter. The nose-plate is made of steel, and is somewhat less in diameter than the body of the plug. It presents the appearance of a low truncated cone, terminated by two short cylinders. On its rear surface it has a "boss," from which projects the stem, which passes through the hole in the axis of the plug. A nut runs upon this stem, and, bearing against the forward face of the hollow, brings the nose-plate to a firm bearing against the forward face of the plug. The forward face of the nose-plate bears against the gas-check ring when the breech is locked. The vent passes entirely through the axis of the nose-plate and stem, the rear orifice being found in the center of the after-end of the stem, and the forward one in the center of the nose-plate.

At the latter point the nose-plate is recessed, and a gas-check is fitted over the orifice of the vent. This vent-check, as it is called, consists of a disk of mild steel, secured over the interior orifice of the vent by four steel screws, which pierce through the disk perpendicular to its flat surface and near its edge. The screws are equidistant from one another, and their heads are not set down hard upon the disk, but allow it to rise about .05 of an inch. The pressure of primer-gas through the vent pushes the disk forward and admits flame to the charge; then the pressure of gas arising from the combustion of the charge forces the disk firmly back upon the orifice of the vent, and prevents all leakage in that direction. The shanks of the four securing-screws act as guides to the disk during its motion. The outer orifice of the vent is found at the rear end of the axis of the stem; but as this is not a convenient place from which to fire the primer, a secondary or offset vent is drilled nearly through a short cylinder of steel, the lower end of which is made to pass vertically down through the nose-plate stem near its rear end. The lower end of the vent in this cylinder is turned at right angles and comes out in the axis of the main vent. The Broadwell gas-check ring is made of copper or steel and fits into the ring-recess. The front of the ring bears against the forward face of the recess, and the face projects .01 of an inch to the rear of the recess wall. The ring is cylindrical on its exterior, fits the recess neatly, and its face is furnished with two circular grooves. The forward side (or curve) of the ring is furnished with an expansion-groove and rib, and the forward face of the nose-plate bears squarely against the face of the ring when the breech-mechanism is locked. See *Ordnance*.

CASUALTIES.—In the military service, a word which includes all losses in numerical strength of officers by death, dismissal, or resignation, and of enlisted men by death, desertion, or discharge; also all losses in fighting strength caused by wounds.

CASUS BELLI.—A phrase used with reference to any event, or complication between sovereign powers, which gives rise to a declaration of war.

CAT—CAT-CASTLE.—In the military engineering of the Middle Ages, a kind of movable tower to cover the sappers as they advanced to a besieged place. The garrison sometimes poured down burning pitch and boiling oil from the walls upon the *cat;* but occasionally this stratagem was disastrous, for the besiegers availed themselves of the blazing tower to burn the wooden gates of the town or fortress.

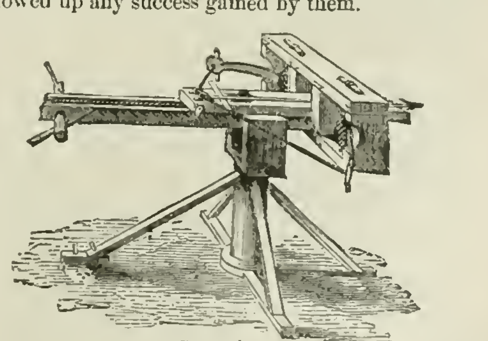
CATAFALCO.—In ancient military architecture, a scaffold of timber, decorated with sculpture, paintings, etc., for supporting the coffin of a deceased hero during the funeral solemnity.

CATALAN FURNACE.—A blast-furnace for reducing iron-ores, extensively used in the North of Spain, particularly in the province of Catalonia, from whence it derives its name, and whence it was probably introduced into Southwestern Europe. It consists of a four-sided cavity or hearth, which is always placed within a building and separated from the main wall thereof by a thinner interior wall, which in part constitutes one side of the furnace. The blast-pipe comes through the wall, and enters the fire through a tuyere which slants downward. The bottom is formed of a refractory stone, which is renewable. The furnace has no chimneys. The blast is produced by means of a fall of water, usually from 22 to 27 feet high, through a rectangular tube, into a rectangular cistern below, to whose upper part the blast-pipe is connected, the water escaping through a pipe below. This apparatus is exterior to the building, and is said to afford a continuous blast of great regularity; the air, when it passes into the furnace, is, however, saturated with moisture. This apparatus is called a *trompe*.

CATAPHRACT.—The old Roman term for a horseman in complete armor. Now obsolete.

CATAPHRACTA.—In the ancient military art, a piece of heavy defensive armor, formed of cloth or leather, fortified with iron scales or links, wherewith sometimes only the breast, sometimes the whole body, and sometimes the horse also, was covered.

CATAPHRACTI.—The cavalry of the Greeks consisted of two kinds. 1. The *Cataphracti*, or heavy cavalry, in which both rider and horse were well covered with defensive armor; the former armed with the lance, and a saber slung from a shoulder-belt. 2. A light cavalry of an irregular character, who were without defensive armor, consisting of archers and lancers, who also carried a sword, javelin, and a small buckler. The position of the cavalry, in line of battle, was on the wings. The duties of this arm were mainly to charge that of the enemy. The Cataphracti, for this purpose, were drawn up on each wing, with a portion of the light cavalry on each of their flanks. The charge was made by the former, and the latter followed up any success gained by them.



Catapult.

CATAPULT—CATAPULTA.—A warlike machine used in ancient times for projecting stones, long darts, or javelins. There were different kinds and sizes of catapultæ to which various names were given. The smaller kinds were in the form of a cross bow; the larger were supported by a frame which sustained two arms moving horizontally, having for a motive force two skeins of catgut. The catapulta was less powerful than the balista, but more uniform in its range. Catapultæ have occasionally been used in modern warfare. There was one erected at Gibraltar by General Melville, for the purpose of throwing stones a short distance over the edge of the rock in a particular place where the Spaniards used to frequent, and where they could not be annoyed by shot or shell.

CATCHPOLE. — A German implement of war, of the fifteenth and sixteenth centuries. It was shaped like the *war-fork*, with sharp points projecting to the rear, was about 14 inches long, and fixed on to a long shaft. This terrible weapon was intended to catch the adversary by the throat and unhorse him.

CATENARY.—The curve formed by a flexible homogeneous cord hanging freely between two points of support, and acted on by no other force than gravity. If the cord is not homogeneous, and the density varies in any regular way, the cord hangs in a curve slightly different in shape from that of the ordinary catenary. The catenary possesses several remarkable properties, one of which is that its center of gravity is lower than that of any curve of equal perimeter, and with the same fixed points for its extremities. Where the cord is such that the weight of any part of it is proportioned to its horizontal projection, the curve is a parabola. The latter curve and the ordinary catenary are of importance chiefly in the theory of suspension-bridges.

CATERVA.—In ancient military writings, a term used in speaking of the Gaulish or Celtiberian armies, denoting a body of 6000 armed men. The word is also used to denote a party of soldiers in disarray; in opposition to *cohort* or *turma*, which signify in good order.

CATGUT.—The material employed in the fabrication of the strings of violins, harps, guitars, and other musical instruments; as also in the cords used by clockmakers, in the bows of archers, and in whipcord. It is generally prepared from the intestines of the sheep, rarely from those of the horse, ass, or mule, and *not* those of the cat. The first stage in the operation is the thorough cleansing of the intestines from adherent feculent and fatty matters; after which they are steeped in water for several days, so as to loosen the external membrane, which can then be removed by scraping with a blunt knife. The material which is thus scraped off is employed for the cords of battledoors and rackets, and also as thread in sewing the ends of intestines together. The scraped intestines are then steeped in water, and scraped again, when the large intestines are cut and placed in tubs with salt, to preserve them for the sausage-maker; and the smaller intestines are steeped in water, thereafter treated with a dilute solution of alkali (4 oz. potash, 4 oz. carbonate of potash, and 3 to 4 gallons of water, with occasionally a little alum), and are lastly drawn through a perforated brass thimble, and assorted into their respective sizes. In order to destroy any adherent animal matter, which would lead to putrefaction and the consequent development of offensive odors, it is customary to subject the catgut to the fumes of burning sulphur—sulphurous acid, which acts as an antiseptic and arrests decomposition. The best strings are used for musical instruments; and those which come from Italy, and are known as *Roman strings*, are the strongest. They are remarkable for their clearness and transparency. Cord for clockmakers is made from the smallest of the intestines, and occasionally from larger ones, which have been split longitudinally into several lengths. Whip-cord is fabricated from catgut, which has been twisted in a manner somewhat similar to single-corded ropes. The catgut obtained from the intestines of horses, asses, and mules is principally made in France, and is employed instead of leather belts for driving machinery.

CATHARINE-WHEEL — CATHERINE-WHEEL.— 1. A form of fire-work having a spiral tube which rotates as the fire issues from the aperture. Catharine is the name of several saints of the Roman Catholic Church. The simple designation of *Saint Catharine*, however, is givin to a virgin, said to have been of royal descent, in Alexandria, who, publicly confessing the Gospel at a sacrificial feast appointed by the Emperor Maximinus, was put to death in 307 A.D., after being tortured on a wheel. Hence the name Catharine-wheel. 2. The Catharine-wheel is frequently used as a charge in coats of arms, when it is represented with teeth.

CAT-O'-NINE-TAILS.—A whip with nine knotted cords. It is occasionally used in the British service for the punishment of soldiers convicted of heinous crimes.

CATOPTRICS.—That subdivision of geometrical optics which treats of the phenomena of light incident upon the surfaces of bodies, and reflected therefrom. All bodies reflect more or less light, even those through which it is most readily transmissible; light falling on such media, for instance, at a certain angle, is totally reflected. Rough surfaces scatter or disperse a large portion of what falls on them, through which it is that their peculiarities of figure, color, etc., are seen by eyes in a variety of positions; they are not said to *reflect* light, but there is no doubt they do, though in such a way, owing to their inequalities, as never to present the phenomena of reflection. The surfaces with which catoptrics, accordingly, deals are the smooth and polished. It tracks the course of *rays* and *pencils* of light after reflection from such surfaces, and determines the positions, and traces the forms, of images of objects as seen in mirrors of different kinds.

A ray of light is the smallest conceivable portion of a stream of light, and is represented by the line of its path, which is always a straight line. A pencil of light is an assemblage of rays constituting either a cylindrical or conical stream. A stream of light is called a converging pencil when the rays converge to the vertex of the cone, called a focus; and a diverging pencil when they diverge from the vertex. The axis of the cone in each case is called the axis of the pencil. When the stream consists of parallel rays, the pencil is called cylindrical, and the axis of the cylinder is the axis of the pencil. In nature, all pencils of light are primarily diverging—every point of a luminous body throwing off light in a conical stream; converging rays, however, are continually produced in optical instruments, and when light diverges from a very distant body, such as a fixed star, the rays from it falling on any small body, such as a reflector in a telescope, may, without error, be regarded as forming a cylindrical pencil. When a ray falls upon any surface, the angle which it makes with the normal to the surface at the point of incidence is called *the angle of incidence;* and that which the reflected ray makes with the normal is called *the angle of reflection.*

Two facts of observation form the groundwork of catoptrics. They are expressed in what are called the laws of reflection of light: 1. In the reflection of light, the incident ray, the normal to the surface at the point of incidence, and the reflected ray lie all in one plane. 2. The angle of reflection is equal to the angle of incidence. These laws are simple facts of observation and experiment, and they are easily verified experimentally. Rays of all colors and qualities follow these laws, so that white light, after reflection, remains undecomposed. The laws, too, hold, whatever be the nature, geometrically, of the surface. If the surface be a plane, the normal is the perpendicular to the plane at the point of incidence; if it be curved, then the normal is the perpendicular to the tangent plane at that point. From these laws and geometrical considerations may be deduced all the propositions of catoptrics. In the present work only those can be noticed whose truth can in a manner be exhibited to the eye without having rigid mathematical proof. They are arranged under the heads *plane surfaces* and *curved surfaces*.

Plane Surfaces.—1. When a pencil of parallel rays falls upon a plane mirror, the reflected pencil consists of parallel rays. A glance at Fig. 1, where PA and QB are two of the incident rays and are reflected in the directions AR and BS respectively, will make the truth of this pretty clear to the eye. The reader may satisfy himself of its truth practically by taking a number of rods parallel to one another and inclined to the floor, and then turning them over till they shall again be equally inclined to the floor, when he will again find them all parallel. 2. If a diverging or converging pencil is incident on a plane mirror, the focus of the reflected pencil is situated on the opposite side of the mirror to that of the incident pencil, and at an equal distance from it. Suppose the pencil to be diverging from the focus Q, Fig. 2, on the mirror of the surface of which CB is a section. Draw QNq perpendicular to CB and make qN=QN; then q is the focus of the reflected rays. For let QA, QB, QC be any of the incident rays in the plane of the figure; draw the line AM perpendicular to CB, and draw AR, making the angle MAR equal to the angle of incidence, MAQ. Then AR is the reflected ray. Join qA. Now it can be proved geometrically, and indeed is apparent at a glance, that qA and AR are in the same straight line; in other words, the reflected ray AR proceeds as if from q. In the same way it may be shown that the direction of any other reflected ray, as BS, is as if it proceeded from q: in other words, q is the focus of reflected rays; it is, however, only their *virtual* focus. If a pencil of rays converged to q, it is evident that they would be reflected to Q as their real focus, so that a separate proof for the case of a converging pencil is unnecessary. The reader who has followed the above will have no difficulty in understanding how the position and form of the image of an object placed before a plane mirror—as in Fig. 3, where the object is the arrow AB, in the plane of the paper, to which the plane of the mirror is perpendicular—should be of the same form and magnitude as the object (as *ab* in the figure), and at an equal distance from the mirror, on the opposite side of it, but with its different parts inverted with regard to a given direction. The highest point, *a*, for instance, in the image, corresponds with the lowest point, A, in the object. He will also understand how, in the ordinary use of a looking-glass, the right hand of the image corresponds to the left hand of the object.

When two plane mirrors are placed with their reflecting surfaces towards each other, and parallel, they form the experiment called the endless gallery. Let the arrow, Q, Fig. 4, be placed vertically between the parallel mirrors, CD, BA, with their silvered faces turned to one another; Q will produce in the mirror CD the image q^1. This image will act as a new object to produce with the mirror BA the image q^2, which, again, will produce with the mirror CD another image, and so on. Another series of images, such as q', q'', etc., will similarly be produced at the same time, the first of the series being q', the image of Q in the mirror BA. By an eye placed between the mirrors, the succession of images will be seen as described; and if the mirrors were perfectly plane and parallel, and reflected all the light incident on them, the number of the images of both series would be infinite. If, instead of being parallel, the mirrors are inclined at an angle, the form and position of the image of an object may be found in precisely the same way as in the former case, the image formed with the first mirror being regarded as a new (virtual) object, whose image, with regard to the second, has to be determined.

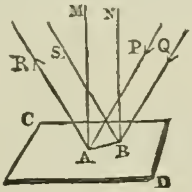


FIG. 1.

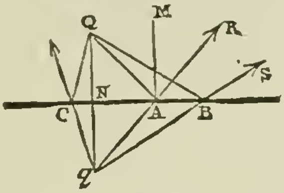


FIG. 2.

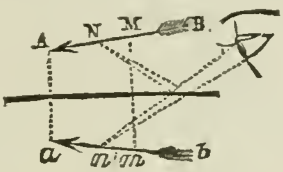


FIG. 3.

3. The two propositions already established are of extensive application, as has partly been shown. They include the explanation of all phenomena of light related to plane mirrors. The third proposition is one also of considerable utility, though not fundamental. It is: When a ray of light has been reflected at each of two mirrors inclined at a given angle to each other, in a plane perpendicular to their intersection, the reflected ray will deviate from its original course by an angle double the angle of inclination of the mirrors. Let A and B, Fig. 5, be sections of the mirrors in a plane perpendicular to their intersection, and let their directions be produced till they meet in C. Let SA, in the plane of A and B, be the ray incident on the first mirror at A, and let AB be the line in which it is thence reflected to B. After reflection at B it will pass in the line BD, meeting SA, its original path, produced in D. The angle ADB evidently measures its deviation from its original course, and this angle is readily shown to be double of the angle at C, which is that of the inclination of the mirrors. It is on this proposition that the important instruments called the Quadrant and Sextant depend.

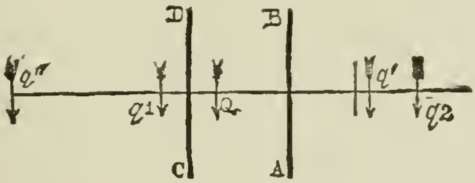


FIG. 4.

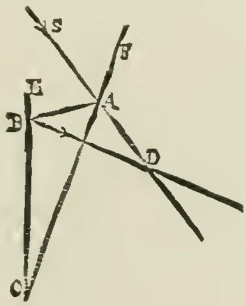


FIG. 5.

Curved Surfaces.—As when a pencil of light is reflected by a curved mirror each ray follows the ordinary law of reflection, in every case in which we can draw the normals for the different points of the surface we can determine the direction in which the various rays of the pencil are reflected, as in the case of plane mirrors. It so happens that normals can be easily drawn only in the case of the sphere, and of a few "surfaces of revolution," as they are called. These are the paraboloid, the ellipsoid, and the hyperboloid of revolution. The paraboloid of revolution is of importance in optics, as it is used in some specula for telescopes. The three surfaces last named are, however, all of them interesting as being for pencils of light incident in certain ways what are called surfaces of accurate reflection—i.e., they reflect all the rays of the incident pencil to a single point or focus. We shall explain to what this property is owing in the case of the parabolic reflector, and state generally the facts regarding the other two.

1. The concave parabolic reflector is a surface of accurate reflection for pencils of rays parallel to the axis or central line of figure of the paraboloid. This results from the property of the surface, that the normal at any point of it passes through the axis, and bisects the angle between a line through that point, parallel to the axis, and a line joining the point to the focus of the generating parabola. Referring to Fig. 6, suppose a ray incident on the surface at P, in the line SP, parallel to the axis AFG. Then if F be the focus of the generating parabola, join PF. PF is the direction of the reflected ray. For PG, the normal at P, by the property of the surface, bisects the angle FPS, and therefore ∠ (angle) FPG = ∠GPS. But SPG is the angle of incidence, and SP, PG, and FP are in one plane, and therefore, by the laws of reflection, FP is the reflected ray. In the same way, all rays whatever, parallel to the axis, must pass through F after reflection. If F were a luminous point, the rays from it, after reflection on the mirror, would all proceed in a cylindrical pencil parallel to the axis. This reflector, with a bright light in its focus, is accordingly of common use in light-houses.

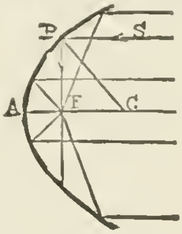


FIG. 6.

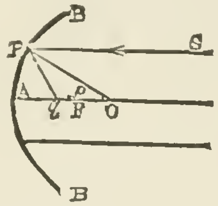


FIG. 7.

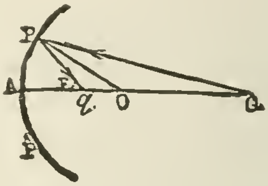


FIG. 8.

2. In the concave ellipsoid mirror there are two points—viz., the foci of the generating ellipse, such that rays diverging from either will be accurately reflected to the other. This results from the property of the figure, that the normal at any point bisects the angle included between lines drawn to that point from the foci.

3. Owing to a property of the surface similar to that of the ellipsoid, a pencil of rays converging to the exterior focus of a hyperbolic reflector will be accurately reflected to the focus of the generating hyperbola.

The converse of the above three propositions holds in the case of the mirrors being convex.

Though the sphere is not a surface of accurate reflection, except for rays diverging from the center, and which on reflection are returned thereto, the spherical reflector is of great practical importance, because it can be made with greater facility and at less expense than the parabolic reflector. It is necessary, then, to investigate the phenomena of light reflected from it.

It is usual to treat of two cases, the one the more frequent in practice, the other the more general and comprehensive in theory. First, then, to find the focus of reflected rays when a small pencil of parallel rays is incident directly on a concave spherical mirror. Let BAB, Fig. 7, be a section of the mirror, O its center of curvature, and A the center of its aperture. AO is the axis of the mirror, and therefore of the incident pencil, because it is incident directly on the mirror; a pencil being called oblique when its axis is at an angle to the axis of the mirror. As the ray incident in the line OA will be reflected back in the same line—OA being the normal at A—the focus of reflected rays must be in OA. Let SP be one of the rays; it will be reflected so that ∠ qPO = ∠ SPO. But ∠ POq = ∠ OPS by parallel lines. Therefore ∠ qPO = ∠ qOP, and Pq and Oq are equal. If, now, the incident pencil be very small—i.e., if P be very near A—then the line Pq will very nearly coincide with the line OA, and Pq and Oq will each of them become very nearly the half of OA. Let F be the middle point of OA—the point, namely, to which q tends as the pencil diminishes. The F is called the principal focus of the mirror, and AF the principal focal length, which is thus = ½ radius of the mirror. It will be observed that when AP is not small, q lies between A and F. Fq is called the aberration of the ray. When AP is large, the reflected rays will continually intersect, and form a luminous curve with a cusp at F. This curve is called the caustic. We shall now proceed to the more general case of a small pencil of diverging rays, incident directly on a concave spherical mirror. Let PAP', Fig. 8, be a section of the mirror, A the center of its aperture, O of its curvature, and let F be its principal focus. Then, if Q be the focus of incident rays (as if proceeding from a candle there situated), q, the focus of the reflected rays, lies on QOA, since the pencil is incident directly, and the ray QOA, being incident in the line of the normal OA, is reflected back in the same line. Let PQ be any other ray of the pencil. It will be reflected in Pq, so that ∠ qPO = ∠OPQ; and on the supposition that PA is very small, so that QP becomes nearly equal to QA, and qP to qA, it can be shown, by Euclid, vi. 3, that $\frac{QO}{QA} = \frac{qO}{qA}$ very nearly. From this equation is deduced the formula $qA = \frac{QA \times AF}{QA - AF}$, which enables us to find qA when QA and AF are known. Thus, let the radius of curvature be 12 inches, and the distance of the source of the rays, or QA, 30 inches, the focal length $qA = \frac{30 \times 6}{30 - 6} = 7\frac{1}{2}$ inches. If the rays had diverged upon q, it is clear they would have been reflected to Q. The points Q and q, accordingly, are called conjugate foci.

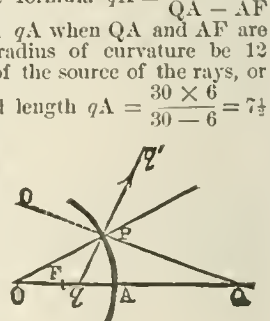


FIG. 9.

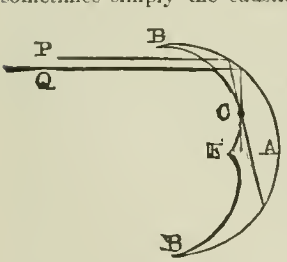
If the mirror be convex, as in Fig. 9, instead of concave, and a pencil of diverging rays be incident directly on it from Q, we should find, proceeding in exactly the same way as in the former case, the equation $Aq = \frac{QA \times AF}{QA + AF}$; or, taking the same numbers as before, $qA = \frac{30 \times 6}{30 + 6} = 5$ inches.

By considering Fig. 8 it is easy to see how the relative positions of the two conjugate foci, as they are called, Q and q, vary as the distance, AQ, of the origin of the rays is changed. As Q is advanced towards O, q also approaches O, since the angles QPO and qPO always remain equal; and when the source of the light is in the center, O, of the sphere, the reflected rays are all returned upon the source. As Q, again, recedes from O, q moves towards F, which it does not quite reach until the distance of Q is infinite, so that the incident rays may be considered as parallel, as in Fig. 7. If Q is placed between O and F, then q will be to the right of O; and when Q coincides with F, the reflected rays will have no focus, but will be parallel. If Q is between F and A, the reflected rays will diverge, and will have their virtual focus to the left of A. The correctness of these deductions may easily be verified. The positions of the conjugates are traced in precisely the same way for the convex mirror, and the reader who is interested will find no difficulty in tracing them for himself.

CAT'S-PAW.—The name given to a particular turn made in the bight of a rope, to which a tackle is fastened. See *Cordage*.

CAULKING.—The operation of driving oakum or untwisted rope into the seams of a structure to render them water tight. The quantity thus driven in depends on the thickness of the planking; it varies from 1 to 13 double threads of oakum, with 1 or 2 single threads of spun-yarn. The caulker first *raims* or *reems* the seam—that is, drives a caulking-iron into it, to widen the seam as much as possible and close any rents or fissures in the wood; he then drives in a little spun-yarn or white oakum with a mallet and a kind of chisel, and afterwards a much larger quantity of black or coarse oakum. The fibers are driven in until they form a densely hard mass, which not only keeps out water, but strengthens the planking. The seam is finally coated with hot pitch or resin.

CAUSTIC.—In optics, *caustic* is the name given to the curved line formed by the ultimate intersections of a system of rays reflected or refracted from a reflecting or refracting surface, when the reflection or refraction is inaccurate. When the caustic curve is formed by reflection, it is called the catacaustic—sometimes simply the caustic; when formed by refraction, it is called the diacaustic curve. In mathematical language, a curve formed by the ultimate intersections of a system of lines drawn according to a given law is called the *envelope*, and is such that the lines are all tangents to it. As in a system of rays reflected or refracted by the same surface *all* follow the same law, it follows that the caustic is the envelope of reflected or refracted rays. An example of the catacaustic is given in the annexed figure for the case of rays falling directly on a concave spherical mirror, BAB', from a point so distant as to be practically parallel. The curve may be said to be made up of an infinite number of points, such as C, where two very near rays, such as P, Q, intersect after reflection. This catacaustic is an epicycloid. The curve varies, of course, with the nature of the reflecting surface. In the case represented in the figure, the cusp point is at F, the principal focus. No such simple example can be given of the diacaustic curve as that above given of the catacaustic. It is only in the simplest cases that the curve takes a recognizable form. In the case of refraction at a plane surface, it is shown that the diacaustic curve is the evolute either of the hyperbola or ellipse, according as the refractive index of the medium is greater or less than unity. The reader may see a catacaustic on the surface of tea in a teacup about half full, by holding the circular rim to the sun's light. The space within the caustic curve is all brighter than that without, as it clearly should be, as *all* the light reflected affects that space, while no point without the curve is affected by more than the light reflected from half of the surface.



CAUTION.—An explanation given previous to the word of command, by which soldiers are called to attention, that they may execute any given movement with unanimity and correctness.

CAVALCADE.—In military history this term implies a pompous procession of horsemen, equipages, etc., by way of parade, to grace a triumph, public entry, and the like

CAVALIER.—1. A term originally signifying any horse-soldier; but in English history, the name given to the party which adhered to King Charles I., in opposition to the Roundheads, or friends of the Parliament.

2. In fortification, a cavalier is a defense-work constructed on the terre-plein, or level ground of a bastion. It rises to a height varying from 8 to 12 feet above the rampart, and has a parapet about 6 feet high. Its uses are to command any rising ground held by the enemy, within cannon-shot, and to guard the curtain, or plain wall between two bastions, from being enfiladed. For these purposes it mounts heavy ordnance. It may be either curved or bounded by straight sides. In modern permanent fortifications, cavaliers are placed either upon the curtains or within the bastions. The latter is the more usual position selected for them. Their plan in this position is usually that of a lunette, the faces and the flanks of which are parallel to those of the enveloping bastion. They receive a considerable command over the parapet of the enceinte, and in some cases are arranged with a tier of casemated fire, above which is an open battery. This arrangement enables the cavaliers to give a plunging fire upon the enemy's works on the glacis of the bastion covered-way. Cuts are made across the bastion-faces, isolating the cavalier from the salient portion of the bastion. They are arranged with parapets. These parapets and the faces of the cavalier in front of them form an interior intrenchment by means of which the breach that might be made in the bastion salient is defended.

CAVALLI BREECH-LOADER.—This apparatus is very simple, and is adapted to the use of a cup or ring gas-check. The sliding block is similar to that of the *wedge breech loader*. The wedge has two handles; the charge is passed through the larger one, the chain preventing too great a movement. The wedge slides on three steel pins, to prevent excessive friction. In case it is stuck by fouling, it may be pried to one side by inserting a handspike in the mortise.

CAVALLI GUN.—A gun invented in 1846 by General Cavalli of the Sardinian service. The chase does not differ essentially from the usual form of cannon; but at the breech of the piece, instead of being round, the four sides are planed off so as to present from the rear an appearance of a square with the corners rounded off. It is bored throughout its length, and rifled with two flat grooves with rounded edges. The rear of the chamber is enlarged, and these grooves being continued through it, although shallower than in the chase, are deep enough to receive the wings or projections on the shot, and hold it up till it reaches its seat in the gun. Crossing the bore at right angles, with its front face perpendicular to the axis of the piece, a wedge-shaped opening with a rectangular cross-section is cut. It is for a 32-pounder 9.4 inches deep, 5.4 inches wide at the large end, and 3.7 inches at the small end. This opening receives the quoin or wedge, made of hardened iron or steel, destined to close the breech in rear of the charge. See *Cavalli Breech-loader*. This gun was designed more particularly for casemate-batteries, or positions where it could be protected by blindages and covers of different kinds. In this gun the mechanical contrivances for securing the breech are very superior to the rude processes of earlier times; but it is very doubtful whether they are sufficiently strong to insure safety when high charges are used in long-continued firing.

CAVALOT.—A very ancient cannon, carrying a ball weighing one pound. Long since obsolete.

CAVALRY.—The earliest records of cavalry as a distinct military organization date far back in the history of Egypt. Diodorus of Sicily states that Osymandias, who lived long before the Trojan War, led 20,000 mounted men against the rebels in Bactriana. Josephus states that the host of Israelites which escaped from Egypt included 50,000 horsemen and 600 chariots of war. Herodotus often alludes to cavalry; and Xenophon relates that in the first Messenian war, 743 B.C., Lycurgus formed his cavalry in divisions. In the year 371 B.C. Epaminondas had a cavalry force of 5000 men, and we know that cavalry contributed greatly to the victories of Philip and Alexander of Macedon. It had an important part in the battle of the Granicus, 334 B.C.; and at the battle of Arbela, 331 B.C., Alexander, who led the Macedonian cavalry of 7000 men, dashed into a gap of the Persian army, and by this brilliant feat utterly routed the enemy. After the death of Alexander, the cavalry of Greece and Macedon greatly degenerated. The Roman cavalry was very inferior to that of Hamilcar and Hannibal, and most of the victories of these two Generals were won by cavalry over the splendid infantry of the Romans. Publius Scipio's defeat at the Ticinus, 218 B.C., was due to the superiority of the Carthaginian horse; and the bitter experience at the Trebia and the battle of Cannæ, 216 B.C., taught the Romans the value of cavalry, by which Scipio finally defeated Hannibal at Zama, 202 B.C. Vegetius states that the Roman cavalry was organized into ten troops or squadrons, forming a regiment of 726 horses, generally attached to some special legion. It is a singular fact that saddles were not in use until the time of Constantine, and stirrups were introduced by the Franks in the fifth century. During the Middle Ages cavalry may be said to have constituted almost the only efficient arm of battle. This was owing to the unwillingness of the nobility in all countries of western Europe to intrust any military power to the serfs; the upper classes went into battle mounted, and both riders and horses had heavy defensive armor. The feudal cavalry consisted of mail-clad knights with their men-at-arms. Their weapons were lances, battle-axes, and swords. The infantry was looked down upon during the Middle Ages, being composed principally of serfs and such as had not the means to keep a horse; but with the invention of gunpowder, the introduction of muskets, and the use of field-artillery a complete change took place; the infantry gradually rose in reputation, and the number of this class of troops was augmented. It seems that light cavalry did not exist as a distinct body, with General Officers and a Staff, before the time of Louis XII. Montluc, however, mentions a General of 12,000 light horse in the time of that monarch; and we hear of Henry II., in 1552, taking a troop of 3000 cavalry in his expedition to Germany. In 1554 Marshal De Brissac formed a corps of mounted infantry, called Dragoons, trained to fight either on horseback or on foot. Maurice of Nassau, who saw the importance of giving more mobility to this arm, was the first to organize cavalry regiments, each regiment being composed of four squadrons, formed in five ranks, and numbering about 1000 horses. Gustavus Adolphus was a great cavalry General, and used his Cuirassiers and Dragoons to good avantage. His tactics were much admired, and were adopted by many European Nations. The French, especially, distinguished themselves after his death in the employment of cavalry. Turenne, Condé, Montecuculi, and Marlborough were considered excellent cavalry leaders in the wars of Louis XIII. and Louis XIV. Cromwell was indebted to his abilities as a cavalry officer for the victories of Marston Moor and Naseby. Defensive armor for cavalry had been abolished in his time, and the cavalry troops were taught to use the carbine. Charges of cavalry were seldom made in battle except by the French; though Charles XII. always made use of cavalry charges at full speed with great effect. Marshal Saxe made many improvements in this arm, and used guns in connection with cavalry at the battle of Fontenoy, although regular horse-artillery was not introduced till 1762. It was not until the wars of Frederick the Great, however, that the full importance of cavalry was developed; he saw the necessity of training these troops to use swords instead of fire-arms, and endeavored to make them perfect riders. No firing whatever was allowed in the battle during the first charge; he claimed that the only two things required to beat the enemy were to charge him with the greatest possible speed and force, and then to outflank him. The brilliant victories he obtained from the adoption of these tactics under the able leadership of Seydlitz have probably never been excelled. At the battle of Hohenfriedberg the Prussian cavalry of 10 squadrons broke 21 battalions, routed the entire left wing of the Austrian infantry, and captured 66 standards, 5 guns, and 4000 prisoners. At the battle of Zorndorf, after the Russians had compelled the Prussian infantry to retreat, Seydlitz, with 36 squadrons rode down the Russian cavalry, and then completely routed their infantry. Frederick had learned to appreciate the true principles of mounted warfare through long experience and the occasional disasters which he had met in the first and second Silesian wars; and it was due to the efficient reforms which he instituted in the Prussian cavalry that he was able to win the battles of Rossbach, Striegan, Kesselsdorf, Leuthen, and others. One of the first improvements made in the French army by Napoleon was the reorganization of the cavalry. He increased the Cuirassiers from one regiment to twelve, and reintroduced the use of the lance and defensive armor. Some of his splendid victories were due to this force, especially at Marengo and Austerlitz; and it was owing to the loss of the French cavalry in the Russian campaign of 1812 that some of his finest achievements in 1813 proved useless: he was well aware of this, and made the statement that had he possessed cavalry at the battles of Lutzen and Bautzen the war would then have been brought to an end. In modern warfare it may be mentioned that cavalry was conspicuous at the battle of Solferino; but in 1866, the first great European war since Waterloo, neither the Austrian nor the Prussian cavalry won great distinction, although the manner in which the Austrian cavalry covered the retreat of their army at the battle of Königgrätz was a noble example of courage and devotion. In the Franco-German war of 1870, however, the excellence of the Prussian cavalry was the chief means of Von Moltke's ability to carry out his strategic plans. The French cavalry were more remarkable for bravery than efficiency. Great progress was made in the cavalry of the United States during the War of the Rebellion; a large number of men of both armies were good riders, and understood the management of horses. They were at first, however, quite ignorant of military tactics, and were used as scouts, as orderlies, and for outpost service. General Sheridan, acting under instructions from General Grant, made the first successful organization of cavalry, which was called the Cavalry Corps of the Army of the Potomac, comprising three divisions of 5000 mounted men each. Their weapons were repeating carbines and sabers. It was with this force that General Sheridan defeated the Confederate cavalry at Yellow Tavern, near Richmond; and it contributed largely to the defeat of Early at the battle of the Opequan, near Winchester; and later, at the battles near Petersburg and at Five Forks, the cavalry took an important part. General Wilson, whom General Sherman put in command of a force called the Cavalry Corps of the Military Division of the Mississippi, did good work in the way of organization towards the close of the war; he had 12,000 mounted cavalry and 3000 who fought on foot at the battle of Nashville, not including a detachment of 3000 men in Kentucky.

Cavalry is usually placed in the rear of the infantry, on ground favorable to its maneuvers, and where it will be masked from fire until the moment arrives to bring it into action; here, if acting on the defensive, the cavalry watches its opportunity to support the other troops, driving back the enemy, by prompt and vigorous charges, when these are hard pressed; or, if on the offensive, biding its time, to rush upon the assailant, and complete his destruction, when his ranks commence to waver or show signs of disorganization from the assaults of the other arms. Its habitual formation for the attack is in a line of two ranks, with a reserve, or support, to its rear. The supports are indispensably requisite to guard against those chances of danger to which cavalry is particularly exposed, if attacked in turn, when in a state of partial disorganization, after a successful charge; or when threatened by an offensive movement against its flanks. The supports offer a safeguard against either of these dangers; for, if the front line is brought up by the enemy, after a successful charge, it can retire and rally in the rear of the supports; and if the enemy makes a movement against the flanks, the supports, placed behind them and in column, can form and anticipate the enemy's charge. For the foregoing reasons, cavalry should not give way to a headlong pursuit after a successful charge, unless its supports are at hand; and in cases where a charge is made without supports, a portion only should engage in pursuit, the rest being rallied to form a support. Cavalry is seldom called on to use fire-arms. When on outpost service, or acting on the defensive on ground unfavorable to charging, a portion of the force may be dispersed as flankers, to hold the enemy in check by their fire. In this case their movements are regulated in the same way as other skirmishers. The defensive qualities of cavalry lie in the offensive. A body of cavalry which waits to receive a charge of cavalry, or is exposed to a fire of infantry or artillery, must either retire or be destroyed. This essential quality of cavalry renders its services invaluable in retreats where the enemy pursues with vigor. In such cases it should be held in constant readiness to take advantage of every spot favorable to its action, and, by short and energetic charges, force the enemy to move with circumspection. So long as infantry maintains its position firmly, particularly if the ground is at all unfavorable to the movements of cavalry, the chances are against a successful attack by the latter. Cavalry should therefore either wait patiently until a way is prepared for its action, by a fire of artillery on the enemy's infantry; or until the infantry has become crippled and exhausted by being kept in action for some time; or else, watching its opportunity, make a charge whilst the infantry is in motion, so as to surprise it before it can form to receive the attack. Cavalry should direct its charge on that point of the enemy's infantry where it will itself be exposed to the least column of fire. If the infantry is in line, the charge should be made on one of its flanks; if in square, on one of the angles of the square; and when several squares are formed, so as to afford mutual support by their fire, selecting the squares on the flanks as most vulnerable, from their position. The formation usually recommended for charging against squares is that of three squadrons in line at double distance; the leading squadron being followed by the others, either directly in its rear, or else the squadrons may be formed in echelon, successively overlapping each other by about the front of a platoon. The angle of the square is charged by each squadron in succession, if the charge of the one preceding it fails; the repulsed squadrons each wheeling to the right or left on retiring, to leave the way clear for its successor. A fourth squadron in column follows those in line, to surround the square and make prisoners if it should be broken by the charge. To draw the fire of the infantry before charging, a few skillful flankers may be thrown forward to open a fire on the square. Stratagem may also be tried, by moving along the front of the infantry, at some 400 paces, and then charging, if it is tempted to throw away its fire at this distance. In an attack where several squares are in line, if one fires to second another it should be instantly charged. In attacks against artillery, the detachment of cavalry should be divided into three bodies; one fourth of the detachment being charged with carrying the guns, one half to attack the supports of the battery, and the remaining fourth acting as a reserve, to cover the parties in advance from an offensive movement against their flanks or rear. The party to secure the guns make their attack in dispersed order, and endeavor to gain the flanks of the battery. When the battery has a fair sweep over the ground along which they must advance, they should, by maneuvering and false attacks, try to confuse the artillerists, and draw their fire before making their charge. The attack against the support of the battery will be directed in the usual manner, the party maneuvering to gain their flanks. See *Dragoon* and *Horse-guards*.

CAVALRY DEPOT.—A depot formed at Canterbury, to which all the depot troops of cavalry regiments abroad are attached.

CAVALRY FORGE.—A recent Board of Officers recommended for the cavalry service, to supply a want long felt, the adoption of a traveling forge-cart, to be issued to each company of cavalry, for the purpose of carrying the blacksmith's bellows, fire-box, anvil, coal, blacksmith's tools, horseshoes, nails, and iron; also for the purpose of carrying the extra ammunition, saddler's tools, and supply of leather for repairs of horse-equipments. The cart was to be an open one, without cover or tail-board, and of such size as to give a stowage of 21.9 cubic feet for tools, coal, and materials, packed in boxes, and arranged for draught by two horses or mules, one in shafts and the other by his side or in front. After the necessary strength to withstand the wear and tear of service, and the desired efficiency to do the required work, the next most important requisite for a forge for the cavalry is light weight, to enable it to move with rapidity. Of late years the smith's bellows for blowing his fire has been gradually giving place, both in portable and stationary forges, to the rotary fan-blower, which has the advantage of giving a much better and steadier blast and occupying less space. These qualities fit it in an eminent degree for use in traveling forges and specially urge its claims for favorable consideration; but it was found on visiting shops where both systems were used that the bellows were preferred by the workmen, and this arose on account of the monotonous and tiresome mode of working the fan-blower, which was done by a crank. This motion does not admit of the same change of position as that for blowing the bellows, but calls in play always the same muscles, and admits of little change or relief. It was clear that in order to make the introduction of the fan-blower a success other means of giving motion to it must be devised. It was observed that sewing-machines and hand-lathes were successfully worked by Hall's treadle, which communicates motion always in the same direction by simply pressing the foot on the treadle, no matter in what position the fly-wheel may be: it has no dead-centers. It was believed that if the blower were arranged to be driven by a lever worked by the hand, so as to enable the man to change his position and shift the work from one hand to the other, the sole objection to the blower would disappear and a better and more constant blast be obtained; the space occupied by it being less, the size and weight of the cart could be diminished. A better disposition of the fire-pan was desirable, so as to obviate the necessity of breaking and forming the connection of the blast-pipe with the fire-pan whenever the forge was to be prepared for the march or for work. This was effected by making this connection permanent, and causing the fire-pan and blower to slide in and out of the body of the cart when required, or not, for use, like a table drawer. It was also deemed advisable to provide the body with a light wooden cover, the better to protect the contents of the boxes from rain and dust.

The drawing represents a side and end view of the cavalry forge, as designed by Colonel Laidley, United States Army, in position and ready for use. When it is packed for traveling, the materials, tools, and implements are all under lock and key and not liable to be lost or stolen. The time required to prepare the forge for work or for transportation is not more than a minute, and the latter can be performed though the fire-pan may be greatly heated. The blast is strong enough to raise the tuyere-plate, weighing four pounds, from its seat, and a baggage-wagon axle may be brought to a welding heat in its fire. It has been found to meet all the requirements of the service, and has furnished the conveniences for keeping shod for five months a wagon-train of 750 horses and mules. It is believed that the advantages gained by having the boxes removable from the body is not commensurate with the expense and additional weight that it necessitates, and it would be better to make them permanent fixtures to the cart.

When using the forge, to prevent the cart from tipping over chock the wheels in front and rear, and let down both props by pulling the handle-rings in front and rear. Unlock and take the key out of the end of the tail-rod; withdraw it. Let down the forge-door and take out the shoeing-box. Grasp the hasp of the forge door with the right hand, insert the middle finger of the left hand in the handle of the locking-bolt; draw out the forge, pulling both hands toward the body; as soon as the forge has moved, let go with the left hand, continuing the action with the right till the locking-bolt stops it. Raise the fulcrum to a vertical position. Unlock and turn the anvil-hasp; seize the anvil-block with both hands; draw it out till the anvil rests near the end of the slide; take the anvil-plate from the fire-pan, screw it on the end of the block, and place the anvil four feet in rear of the cart and six inches to the left of the left wheel; withdraw the brake-handle from its pocket, hook the end in the link, and enter the handle in the slot in the fulcrum on the right, if the smith have a helper; on the left if he have none. Bear down on the handle gently at first, raise it a foot and bear down somewhat harder, increasing the pressure as the fan gains speed, continuing this pumping motion, and varying the rapidity of the stroke according to the amount of blast required. To remove the forge from the cart, place two trestles parallel to each other, 16 inches apart; raise them to a height of 2 feet 8 inches. Two men, one on each side of the forge, take hold of it; one pulls the handle of the stop-bolt, and both draw the forge to the rear and place it lengthwise on the trestles. Take out the smith's chest and coal-box in the same way and place them in convenient places. The saddler's chest may be taken out or left in the cart after the others have been removed.

The following are the principal dimensions and weights:

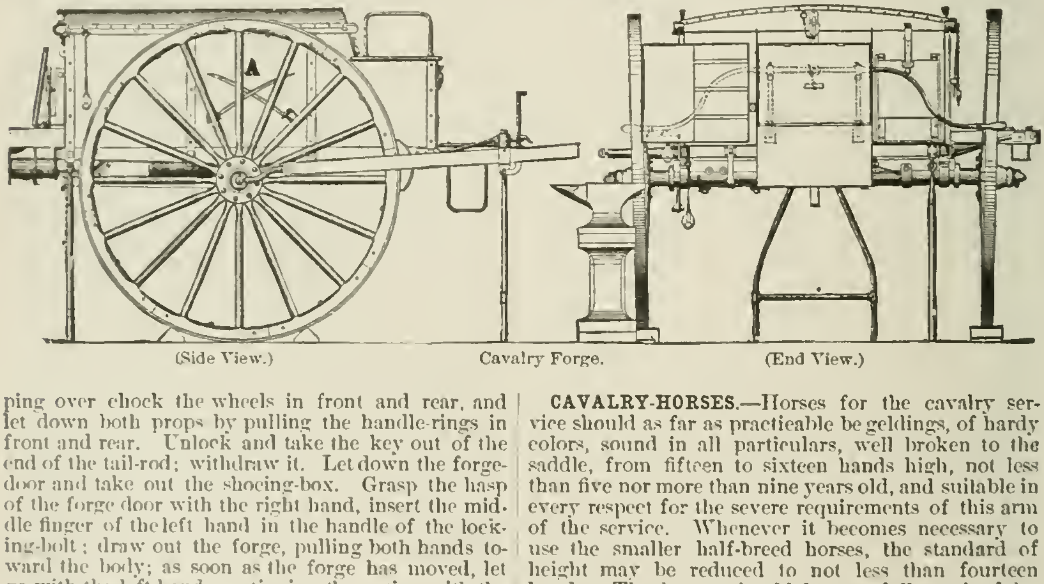
Dimensions.

Width of track of wheels...........	62	inches.
Whole length of axle...............	83½	"
Width of body......................	47	"
Length of body.....................	66	"
Length of cart, including shafts......	154	"
Height of wheel....................	57	"

Weights.

One wheel	108	pounds.
Shafts (both)	47	"
Anvil-block and base...............	106	"
Forge, hood, etc	145	"
Tool-box, empty................ ...	55	"
Coal-box, empty................ ...	63	"
Coal-box, filled with coal...........	228	"
Saddler's box.................. ...	44	"
Whiffletree	4	"
Tuyere.............................	4	"
Anvil-base.........................	7½	"
Cart (complete), empty.............	1075	"

See *Blower* and *Traveling Forges.*



(Side View.) Cavalry Forge. (End View.)

CAVALRY-HORSES.—Horses for the cavalry service should as far as practicable be geldings, of hardy colors, sound in all particulars, well broken to the saddle, from fifteen to sixteen hands high, not less than five nor more than nine years old, and suitable in every respect for the severe requirements of this arm of the service. Whenever it becomes necessary to use the smaller half-breed horses, the standard of height may be reduced to not less than fourteen hands. The horses should be carefully trained by the best horsemen, under the supervision of an officer or non-commissioned officer. Extreme gentleness and patience must be used, and loud talking and shouting avoided. By careful treatment at first, most horses soon become perfectly gentle and tractable. Mere force, without skill or coolness, only serves to confirm bad habits. Approach the horse on the near side, speak to him gently, place the right hand on his haunch, and step into the stall beside him. Take hold of the halter-strap; pat the horse and speak to him gently until he permits his legs to be rubbed and his feet to be lifted. As soon as the horse becomes quiet in handling, he is bridled with the watering-bridle, great care being taken not to frighten or hurt him. The blanket is then folded and placed on the horse; if the horse show any fear of the blanket, lay the blanket over the left arm, and go into the stall, show the blanket to the horse and permit him to smell it, patting him on the neck until he is quiet and allows the blanket to be placed on his back; then place the surcingle gently over the blanket and buckle it. The horse is now led out of the stable, and is patted and coaxed until he becomes perfectly quiet and stands still while the man goes about on both sides, rubs him, takes up his feet, etc., and at length permits the man to get on his back. After mounting, the man pats the horse for a few moments, without attempting to make him move, and then dismounts. This is repeated several times, until the horse submits without fear. It must be remembered that the efficiency of cavalry depends almost entirely upon the *condition of the horses,* which alone makes them able to get over long distances in short spaces of time. The horses must, therefore, be nursed with great care, in order that they may endure the utmost fatigue when emergencies demand it. Reveille, ordinarily, should not be sounded on the march before daylight, as horses rest better from midnight until dawn than at other times. The average march for cavalry is from fifteen to twenty miles per day. The walk is the habitual gait, but, when the ground is good, the trot may be used occasionally for short distances. Long marches or expeditions should be begun moderately, particularly with horses new to the service. Ten or fifteen miles a day is enough for the first marches, which may be increased to twenty-five miles when necessary, after the horses are inured to their work. The march is usually in column of fours; when practicable, it may be in double column of fours; in small commands it is often in column of twos. In small commands, not in campaign, distances of forty to fifty yards may be taken between the companies, so that checks will not extend from one to another and cause unnecessary halts. A halt of from five to ten minutes is made at the end of every hour, for the purpose of adjusting equipments, tightening girths, etc. The companies are dismounted in column at the command of their Captains; if there be grass, each Captain first obliques his company a short distance from the road to let the horses feed, as horses must always be encouraged to graze as much as possible on the march. When troops march for the greater part of the day, a halt of from twenty to forty-five minutes is usually made about noon. On long marches, officers and men, except the sick, should be required to dismount and lead from twenty to forty minutes every second or third hour; to save their backs, horses should be led over steep ground, and particularly down hill. See *Horse* and *Horsemanship.*

CAVALRY-PARRIES.—Important movements in bayonet-exercise, executed as follows: The Instructor commands—1. *High tierce,* 2. PARRY. Turn the piece, barrel to the left; support it with the right elbow against the hip, the barrel between the thumb and forefinger of the left hand; the left forearm above and about eight inches in front of the head; the piece about eight inches to the right of the head, covering the head and right shoulder. 1. *High quarte,* 2. PARRY. Carry the piece to the left of the left shoulder, the barrel to the right and nearly vertical, the right hand at the small of the stock, the left elbow at the height of the shoulder and touching the right wrist, the fingers on the stock. 1. *High prime,* 2. PARRY. Raise the piece with both hands, about eight inches in front and four inches above the head, the barrel downward and supported between the thumb and forefinger of the left hand midway between the upper and lower bands. The positions are shown in Figs. 1, 2, and 3. The *thrusts* and *lunges* are executed after each cavalry-parry, the bayonet elevated. In the thrust from *high tierce* and *prime* the barrel is downward; in *high quarte* the barrel is upward. The high double parries are executed as follows: 1. *High tierce,* 2. QUARTE. 1. *High quarte,* 2. TIERCE. 1. *High prime,* 2. SECONDE. 1. *Seconde,* 2. HIGH PRIME. The *seconde* is the same for cavalry as for infantry. See *Bayonet-exercise* and *Parry.*

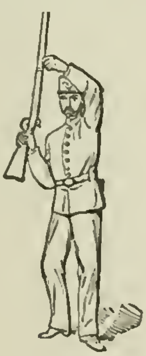


FIG. 1.

FIG. 2.

FIG. 3.

CAVALRY TACTICS.—Authorities differ concerning the proportion that ought to be observed between cavalry and infantry in an army. In France and Austria the ratio is about 1 to 5; in Prussia and Bavaria, 1 to 4; in Russia, 1 to 6; in England, 1 to 8; and in the United States, 2 to 5.

So far as concerns actual duties, heavy cavalry charge the enemy's cavalry and infantry, attack the guns, and cover a retreat; while the light cavalry make reconnaissances, carry dispatches and messages, maintain outposts, supply pickets, scour the country for forage, aid the commissariat, pursue the enemy, and strive to screen the movements of the infantry by their rapid maneuvers on the front and flanks of their army. At the battle of Balaklava the heavy-cavalry charge was within the reasonable duties of the troops, but that of the light cavalry was not; the former succeeded, the latter failed. A cavalry-horse will walk 4 miles in an hour on general service, trot 8 miles in maneuvering, and gallop 11 miles in making a charge. The cavalry usually attack in line against cavalry, in echelon against artillery, and in column against infantry. When an attack is about to be made, the cavalry usually group into three bodies—the attacking, the supporting, and the reserve. Close combat and hand-to-hand struggle are the province of cavalry; infantry and artillery may fight at a distance, but cavalry cannot. It is rare that two bodies of cavalry stand to fight each other; the weaker of the two, or the less resolute, usually turns and gallops off. The work to be done by the horse is to pursue, to overwhelm, to cut down. They cannot wait to receive an attack like infantry; they must either pursue or retreat; and on this account it has been said, "Rest is incompatible with cavalry." The infantry and artillery more frequently win the victory; but the cavalry prepare the way for doing this, capture prisoners and trophies, pursue the flying enemy, rapidly succor a menaced point, and cover the retreat of infantry and artillery, if retreat be necessary. Cavalry is necessary to finish off work mainly done by others; and without its aid signal success is seldom obtained on the field. Many of the brilliant achievements of the British in 1857 and the following year, in India, were rendered almost nugatory by the paucity of cavalry, while, as a contrast, the German victories of 1870 were enhanced by the splendid services of their Uhlans and other light cavalry. See *Cavalry* and *Tactics*.

CAVEATING.—In fencing, a motion whereby a person in an instant brings his sword, which was presented to one side of his adversary, to the opposite side. See *Fencing*.

CAVESSON.—A sort of nose-band, of leather or iron, which is put on the nose of a horse to assist in breaking or training him. It resembles the *twitch* or *barnacles*, being a grip by which the nose is wrung and twisted, to subdue the refractory spirit of the animal. Otherwise spelt *causson* or *cavezon*.

CAVIN.—In military affairs, *cavin* implies a natural hollow sufficiently large to lodge a body of troops and facilitate their approach to a place. If it be within musket-shot, it is a place of arms ready made, and serves for opening the trenches, free from the enemy's shot.

CAXON.—A chest of ores, calcined, ground, and washed, ready for the refining-furnace. From the Spanish *caxon*, *cajon*, a large chest.

CELERES.—A body-guard of 300 young men of the best Roman families, organized, according to tradition, by Romulus. Next to the king, their leader was the highest officer of the State. This position was held by Brutus when he expelled the Tarquins.

CELLS.—Places of solitary confinement in which soldiers are placed, as punishment for certain crimes. In England and elsewhere this confinement is limited to 168 hours.

CELLULOID.—A remarkable modern invention, apparently capable of wide usefulness in the arsenal and laboratory, wherever India-rubber and various kinds of cloth are now employed. Celluloid is produced by mixing gum camphor with a pulp of guncotton, and subjecting the combination to a high degree of pressure and heat. The result is a hard product of extraordinary toughness and elasticity. It can be made plastic again and molded into any required form. Any color can be given to it by the use of coloring matter during the process of manufacture. It is extensively used as a substitute for ivory, which it resembles so closely that it is sometimes difficult to detect the difference.

CELT.—The name by which certain remarkable war-weapons of the early inhabitants of western Europe are known among archæologists. Celts are either of *stone* or of *bronze*.

Stone celts vary in length from about 1 inch to 22 inches; but the most common size is from 6 to 8 inches in length, and from 2 to 3½ inches in breadth. They are made of almost every kind of stone, and show considerable diversity of shape, almost all, however, having more or less resemblance to the mussel-shell. The ruder celts are generally of slate, shale, schist, or grit; the finer, of flint, porphyry, greenstone, syenite, or agate. Many of the finer celts are beautifully shaped and highly polished. A remarkable example of this class, the property of Sir Coutts Lindsay, found near St. Andrews, in Scotland, is described by Sir David Brewster in the *Philosophical Journal* for 1823. Recently a class of celts found in the later geological strata have excited much interest as well among archæologists as among geologists. They are obviously of the same type with the more common celts, but of ruder construction, as if fashioned by a more barbarous people. The stone celt was fastened into a handle of horn, bone, or wood. A celt of serpentine, with a handle of deerhorn, was found in one of the Swiss lakes in July, 1859, and a stone celt, with a wooden handle, in the County of Tyrone, in Ireland.

Bronze celts vary in length from about 1 inch to 8 or 10 inches, the most common length being about 6 inches. They are sometimes ornamented with rudely incised lines or circles, and have occasionally been found wrapped up in linen, or inclosed in bronze cases or sheaths. They show much greater diversity of shape than the stone celt. As many as four classes have been distinguished by archæologists: 1st. The simple wedge-shaped celt, most nearly resembling the common form of the stone celt. 2d. The wedge-shaped celt, with sides more or less overlapping, and a stop-ridge or elevation between the blade and the part which received the handle. 3d. The wedge-shaped celt, with sides greatly overlapping, with or without the stop-ridge, but with a loop or ear upon, and parallel to, its lower surface. 4th. The socketed celt, or the celt with a hollow to receive the handle, and generally with a loop or ear upon its lower surface.

Both stone and bronze celts were probably used for several purposes, serving for chisels, adzes, and axes, as well as for weapons of war, like the stone hatchets of the South Sea Islanders and other savage or barbarous tribes. Examples of stone and bronze celts of all classes (together with the molds in which bronze celts were cast) may be seen in the British Museum at London, in the National Museum of the Antiquaries of Scotland at Edinburgh, and in the Museum of the Royal Irish Academy at Dublin. The last collection has more than 500 examples of stone celts, about one half of which were found in deepening the bed of the Shannon or its tributaries, between the years 1843 and 1848. A bushel of bronze celts has more than once been discovered at one spot.

CELTIBERI.—A powerful people of ancient Spain, supposed to have sprung from a blending of the Iberians or Spanish aborigines with Celtic invaders from Gaul. The Celtiberi inhabited a large inland district of the peninsula, corresponding to the southwest half of Aragon, nearly the whole of Cuença and Soria, and a great part of Burgos, but the name Celtiberia had often a wider signification, including the country as far south as the sources of the Guadalquivir. The Celtiberi were divided into four tribes, and were unquestionably one of the bravest and noblest peoples in the peninsula. Their cavalry and infantry were equally excellent. For many years they withstood the efforts of the Romans to subdue them, and it was not till after the campaigns of Sertorius that they began to adopt the Roman language, dress, and manners.

CEMENT.—A cement is a substance used to make the surfaces of solid bodies adhere to one another; it is applied in a liquid or viscous state, and hardens after the surfaces are brought together. When fused metals or alloys are used in this manner, they are called solders. There is a great variety of cements derived from animal, vegetable, and mineral substances. The animal cements are chiefly composed of gelatine and albumen as their bases. Joiners' glue is an example. The binding materials of vegetable cements are gums, resins, and wax. The mineral cements are chiefly of lime and its compounds. In many cements, animal, vegetable, and mineral substances are combined. The simplest of the mineral cements is plaster of Paris, which is used for uniting slabs of marble, alabaster, and many similar purposes. It is mixed with water to the consistence of thick cream, and then applied. This hardens rapidly, but is not very strong. Its hardening depends upon the true chemical combination of the water with anhydrous sulphate of lime, of which plaster of Paris is composed, and the formation thereby of a solid hydrate. The plaster of Paris may be mixed with thin glue, with diluted white of egg, or a solution of size or gum, instead of water, and is strengthened thereby. Keene's marble cement is prepared by steeping plaster of Paris in a concentrated solution of alum, then recalcining and powdering. This powder is mixed with water in the same manner as plaster of Paris.

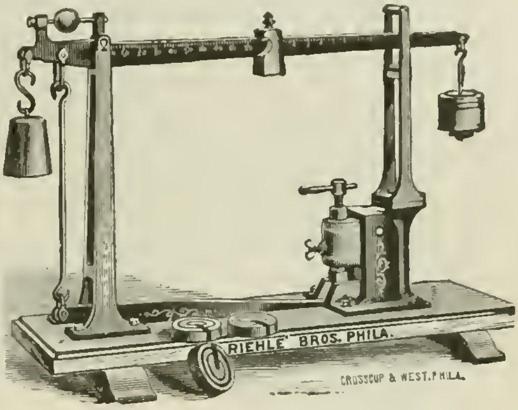
It is used as a stucco for internal decorations, takes a high polish, and when colored forms beautiful imitations of mosaic, marbles, scagliola, etc. A mixture of paper-pulp, size, and plaster of Paris in equal proportions forms a useful cement, and is also used as a sort of papier-mâché for casting into architectural ornaments, etc. Common mortar is one of the most important of the lime cements. It is composed of slaked lime, or a mixture of this with sand; its hardening depends upon the slow formation of carbonate of lime by the absorption of carbonic acid from the atmosphere, and a partial combination with the silica of the sand. Cow-hair is sometimes mixed with it, to bind it when laid in masses. In order to obtain a fine smooth paste, which is required for good mortar, the lime should be slaked rapidly by adding about three parts of water to one of lime; if the quantity of water is too small, a coarser or semi-crystalline hydrate of lime is produced by the slaking. Ordinary mortar, when exposed to the continuous action of water, softens and disintegrates, and some of the lime dissolves away. Lime which contains 20 or 30 per cent of clay, or finely divided silica, produces a mortar which is not liable to this softening, but possesses the property of hardening under water; such lime is called *hydraulic*, and the mortar made from it, hydraulic cement or mortar. Puzzolana, a porous lava found at Puzzuoli, near Naples, has been long celebrated for its property of forming a hydraulic cement when mixed with ordinary lime. It is mainly composed of silicates of alumina, lime, and soda. Portland cement, so named from its resemblance to Portland stone when dry, is made from clay found in the valley of the Medway, which is intimately mixed with the neighboring chalk, and then burned. Roman cement is similar to the Portland, but of a darker color; it contains a larger proportion of clay, and solidifies more rapidly. These cements should be mixed with a sufficient quantity of water to form a moderately thick paste; the surfaces to which they are applied should be well wetted, and the cement kept slightly moist until it hardens. The solidification of hydraulic cements depends upon the combination of the lime with the silica and alumina, forming first a hydrated compound, and finally a true silicate. They expand slightly in solidifying. See *Cement-tester.*

CEMENTATION.—The process of infusing a solid body with the constituents of another body in which it is buried, by the application of heat. The production of steel by cementation consists essentially in the exposure of bars of malleable iron, in close contact with charcoal, to a high and long-continued heat, the air being excluded. A decided peculiarity of the converted bars is the blistering of the external surface, whence the term *blister-steel* is derived. When the blisters are small and regularly distributed, the steel is of good quality; but when large, and only occurring along particular lines, they may be considered as indicative of defective composition or want of homogeneity in the iron employed. See *Blistered Steel.*

CEMENT-TESTER.—A machine for ascertaining the strength of cement, mortar, or other similar material by compression. The drawing shows an improved machine of this class with the following dimensions: Extreme height, 2 feet 4 inches; extreme length, 3 feet 6 inches; extreme width, 1 foot 5 inches; weight, 110 pounds. Adaptation—Crushing specimen, 1-inch cube or less; motion of screw, $1\frac{1}{2}$ inch; capacity, 1500 pounds.

The beam is of brass, with sliding poise and graduated from 1 pound up to the capacity of 1500 pounds The levers being carefully sealed to the United States standard, the results of the tests are positively correct. The specimen (1-inch cube) is shown in position at butt end of main lever just below the thumb-screw. The following simple directions will show how to operate the machine:

After the specimen is properly adjusted in place, force the screw down with the hand-lever until you have got enough pressure on to make the lever nearly touch the top of the stand; the weight on the beam is then carefully increased and the specimen will, in most cases, break before the beam reaches the bottom



of the stand or gate. If, however, it should not, the beam is again raised by applying pressure with the screw and moving the poise on beam until the specimen breaks or the desired test is applied. See *Testing-machine.*

CENOTAPH.—A monument which does not contain the remains of the deceased. They were originally erected for those whose bones could not be found; e.g., for those who had perished in battle. Latterly the name was applied to tombs built by a man during his lifetime, for himself or for the members of his family.

CENTER.—One of the points on the lathe-spindles on which the work is placed. The *front* or *live center* is on the spindle of the *head-stock.* The *back* or *dead center* is on the *tail-stock.* The *centers* of a planer are on stocks temporarily attached to the bed of the planer, so that the object may be turned on its axis in the course of the work thereon. See *Lathe.*

CENTER-FIRE METALLIC-CASE CARTRIDGE.—The successful invention of the self-primed metallic-case cartridge has greatly simplified the construction of breech-loading small-arms. Prior to its introduction and use, the prevention of the escape of flame through the joint of the breech was of difficult if not impossible accomplishment, and complicated arrangements of the breech-mechanism had to be resorted to, with, at best, unsatisfactory results. The metallic cartridge overcomes this difficulty, being itself a perfect gas-check renewed at every round, prevents foulness and wear of the mechanism, and exercises the most vital functions in the life of the arm. So important an element is it that it may be said that with a perfect cartridge the most indifferent breech arrangement can be used with safety and efficiency.

Its advantages, other than that already indicated, are many: its completeness and simplicity, being self-primed, and used as a whole in loading; its strength and safety, withstanding the roughest usage and thoroughly protecting the powder and fulminate; its accuracy, because of the coincidence of the axis of the bore and bullet; and, added to these, the absolute impossibility of using more than one cartridge at a time.

That adopted by the Ordnance Department is known as the *center-fire.* The superiority of this system over the rim-fire is so marked as will undoubtedly lead to its universal adoption. By concentrating the percussion-composition in the center of the head the quantity used is reduced to a minimum,—to less than one fourth of what is required to prime the entire circumference in the rim-fire,—and this smaller quantity is so much better protected as not to be at all liable to accidental explosions. The central portion of the head has more elasticity than the rim, and is better able to resist the strain upon it from the sudden action of the fulminate, besides having the additional advantage of permitting the reinforcing of the rim, thus strengthening the weakest portion of the cartridge-case.

The United States regulation center-fire cartridge, caliber .45, consists of the following parts, viz.: the

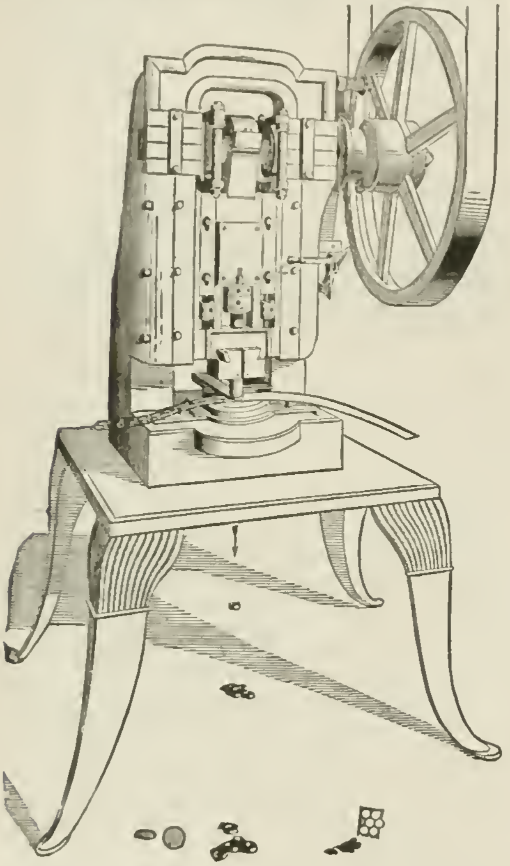


Fig. 1.

case, the *cup-anvil*, ½ grain of *percussion-composition*, 70 grains of *musket-powder*, and a lubricated *leaden bullet* weighing 450 grains. The case is the copper tube which forms the receptacle for the powder-charge, the percussion-composition, and the leaden bullet. Its exterior conformation is designed to facilitate its ready extraction from the chamber of the gun after firing. Besides the rim at the closed end, which is intended primarily to assist extraction, the case is tapered from the rear to a point where it seizes the bullet, whence it merges into a right cylinder. The cup-anvil is a small metallic cup, of sufficient rigidity to resist the blow of the hammer communicated by the firing-pin, and of such form as to insure the passage of the flame to the powder-charge upon the explosion of the percussion-composition. It is provided with a circular recess or cavity into which the percussion-composition is deposited. Two little vents, at the extremities of a diameter of this recess, direct the flame to the charge. The cup, when charged with the composition, is placed within the copper case, pressed snugly against its closed end, and crimped firmly into position. Cups were formerly made of sheet-iron tin-plate, but they are now made of copper. The bullet enters more than half its length into the case, in order that the lubricant in its grooves may be entirely covered and protected. To render the cartridge water-proof, the edge of the case is crimped hard against the bullet.

The sheet-copper for making the cases is No. 22, wire gauge, obtained in strips 35¼ inches long, 3.3 inches wide, and .03 inch thick. The ends of these strips are cut at an angle to avoid waste, and each strip gives material for 40 cases. One pound of copper will make 40 cases, ⅓ scrap. In the selection of sheets for making the cases, such only should be chosen as appear to have been rolled in a careful manner. They must be free from the slightest seams, blisters, or flaws, and of an even thickness throughout, well annealed, and trimmed to the foregoing dimensions. The best copper ores are mined on the shores of Lake Superior. The Minnesota mines and the most approved brands of Detroit smelting should be selected in preparing metal for cartridge purposes. It is not pure as received from the mills, being alloyed with 5 per cent of spelter.

The first operation in drawing the tubes is performed by the double-action press, shown in Fig. 1. The strips of copper are prepared for the press by straightening their ends and edges, if necessary, with a hand-mallet, and oiling both surfaces. The strips are then fed to the press by hand, a small stop on the die-plate regulating the length of feed. The first

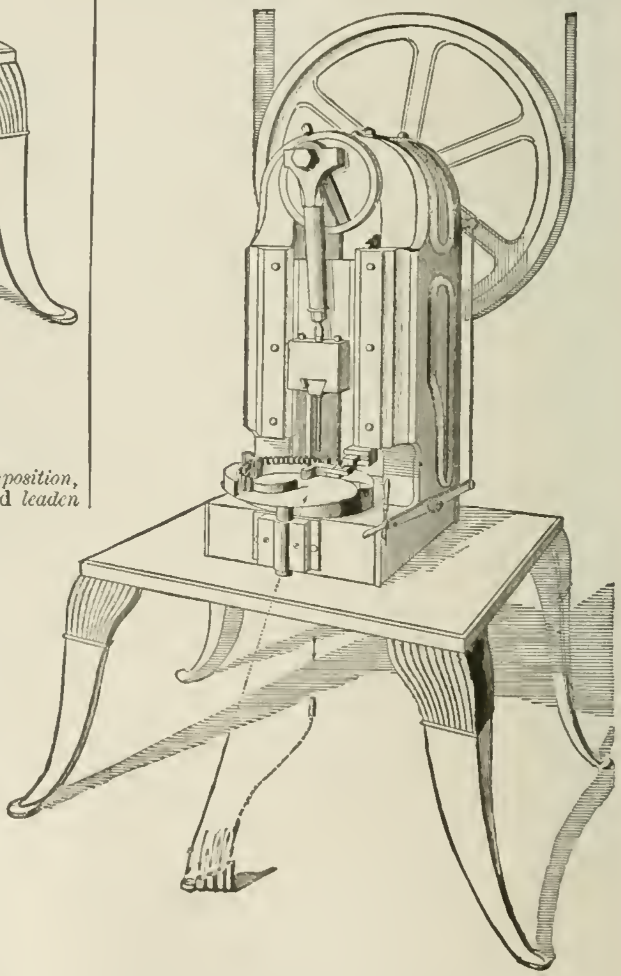


Fig. 2.

shape given to the future cartridge-case is that of a flat circular disk, 1.63 inch in diameter, cut from the copper strips fed under the double punch of this press. This punch is essentially a punch within a punch, the exterior one cutting the disk clear from the strip, while the interior one descends and forces it through a tapered die, giving it a shallow, cup shape, about 1 inch in diameter and .5 inch deep. After passing through and beyond the tapered die, the cup expands slightly and is stripped from the interior punch as the latter ascends. Two rows of disks are cut from each strip, one disk at a time. They are cut and cupped at the rate of 65 a minute. Experience has proved that a width of strip giving only two rows of disks is better than a width giving three or more rows, the former being rolled to a more uniform thickness and subject to less percentage of waste.

In order to draw the cups to the dimensions required for the finished cases, they are subjected to the action of four additional punches and dies of decreasing sizes, so as to gradually elongate the cups while reducing their diameters. These draws are made by single-action presses, having each a single punch and die, as shown in Fig. 2. The first press elongates the cup from .92 to .95 of an inch, and reduces its diameter to (according to the maximum thickness of copper and wear of tools) about .7 of an inch. The second press elongates it from 1.15 to 1.2 inch, and reduces the diameter to about .65 of an inch, thus lengthening out the cup into a tube. These tubes at this stage are annealed after a process

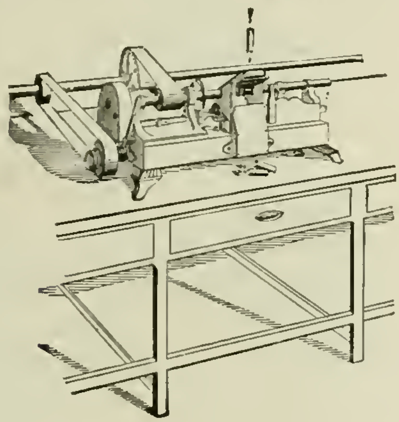


FIG. 3.

to be presently described. The third press elongates the tube from 1.75 to 1.8 inch, and reduces its diameter to .55 of an inch. The fourth press brings the tubes to the required exterior diameter of .501 minimum and .503 maximum of an inch, the extreme permissible variation of which is .002 of an inch; but they are left of unequal lengths and with ragged edges. These presses are fed at the rate of 65 tubes a minute, by placing them upright on a revolving horizontal plate provided with guides and stops.

The tubes are annealed after the second draw, as stated above, to restore to the metal its ductility, the previous operations having rendered it hard and brittle. The number of annealings required during the entire process of manufacture will depend on the quality of the metal used; with the best copper, only one is necessary. The annealing is done by placing the tubes in a perforated iron cylinder, heating them red-hot in a charcoal-fire, revolving the cylinder meanwhile to equalize the heat, then plunging them into a solution of one part of sulphuric acid and fifteen parts water, and, afterwards, thoroughly washing in several changes of water to remove all trace of acid. The acid solution (pickle) is intended to cleanse the metal from any scale, or oxide, occasioned by the annealing. They should be kept in a slightly acid bath until ready for use, when they are washed and oiled.

The finishing draw having left the tubes of unequal lengths and ragged edges, it is necessary, in order to facilitate the subsequent steps of manufacture, and to insure uniformity in the finished cartridges, to remove the ragged edges and reduce the tubes to a uniform length. This is done by means of the trimming-machine represented in Fig. 3. The tubes are placed in the trough of this machine, whence they are taken up by a revolving mandrel, against which, and just inside of a shoulder upon the same, the edge of a circular cutter is pressed. The tube, when brought to position by the mandrel, is cut clean and even by the cutter, a stripper removing the tube and scrap after each operation. To allow for the metal that is used for forming the head or rim, the tubes are cut a little longer (about .13 inch) than the headed case. The tubes are trimmed by this machine at the rate of 80 a minute.

In all the operations previous to and succeeding the annealing, lard-oil of the best quality is the lubricant used. But as the smallest particle of oil will impair the efficiency of the percussion-composition, it is of the last importance that all vestiges of it be removed from the interior of the tube before the percussion-

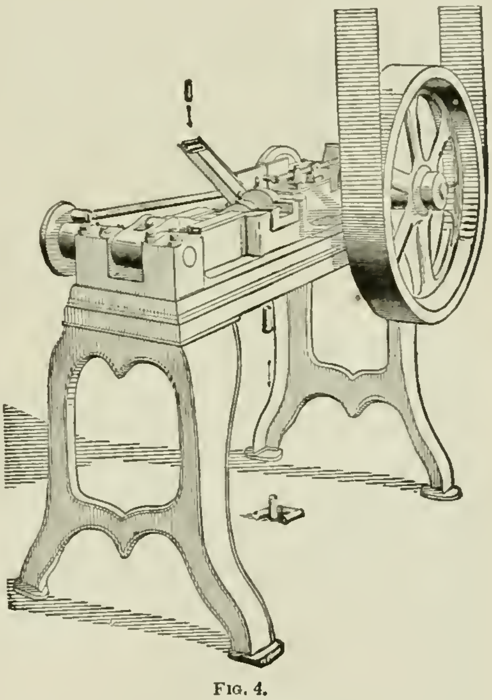


FIG. 4.

composition is inserted, The flattening of the closed end of the tube by the next operation would, if the oil were not previously removed, retain a greater or less quanity of it in the interior fold of the rim, from which no subsequent process could entirely remove it, and from which it would be liable to exude in the finished cartridge, to the destruction of the percussion-composition. The present unheaded condition of the tube, therefore, affords the most favorable opportunity for removing the oil, which is done by washing the tubes in a solution of $1\frac{1}{2}$ pound potash, $1\frac{1}{2}$ pound soda, and 5 gallons of water, temperature 120°, for seven minutes, and afterwards rinsing them thoroughly in clean warm water, using a revolving wire barrel partially immersed in it.

The head or rim of the cartridge-case is next formed by the heading-machine. This machine, shown in Fig. 4, consists of a horizontal die, countersunk at one end for sizing (diameter and thickness) the head, a feed-punch to insert the tubes into the die, and a heading-punch to flatten the closed end of the tubes into the countersink. The bumper may be reversed, and the die left without countersink. This plan has been recommended. The tubes, which are a little longer than the headed case, are fed into the inclined trough of the heading-machine, whence they are taken up on the feed-punch. A shoulder on this punch, at a distance from its extremity equal to the inner depth of the headed case, prevents it from extending to the full depth of the tube, and a surplus

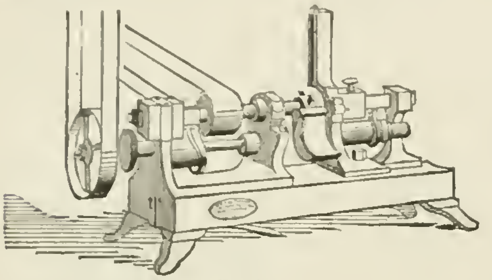


Fig. 5.

of metal is thereby left at the closed end of the tube for the formation of the head. The feed-punch inserts the tube into the die, and holds it there, while the heading-punch moves forward by a powerful cam, and presses and folds the unsupported projecting portion of the tube into the countersink of the die or recess of bumper, as the case may be, forming and accurately sizing and shaping the head or rim. The headed case being left in the die as the feed-punch recedes, is pushed out by the succeeding tube and thrown by a flipper into the receptacle below. No oil is used in this operation, the moisture of the tubes from the recent washing sufficing as a lubricant. The machine is fed at the rate of 65 per minute. The cases are now finished; but to be certain that the oil is entirely removed from them, they are again washed in the alkaline solution and dried thoroughly in a drying-room, at a temperature of about 125° Fahrenheit.

The cup-anvil is made of copper, by a double-action press, similar to the one for cutting and cupping the disks for the copper cases. Copper sheet-metal strips, 25 inches long, 2.5 inches wide, and .045 inch thick are used. One pound will make 176 cups, ½ scrap. The sheet-metal for cups must be free from all defects, with a bright, smooth surface, and uniform in thickness throughout, and annealed. The cups are cut and formed by this machine at the rate of 45 a minute. The cup-anvils, as they come from the double-action press, are of the right diameter, but too long, and with ragged edges. The cups are reduced to a uniform height by cutting off the ragged edges in the cup-trimming machine, shown in Fig.

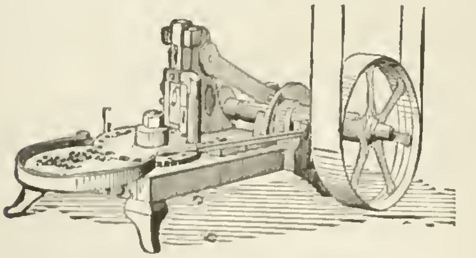


Fig. 6.

5, which consists of a revolving rose cutter, made of a number of small cutters that can be changed and sharpened at pleasure. The cups are fed to the cutters through a vertical trough, and are trimmed at the rate of 30 a minute. The vents are punched in the trimmed cups by the cup-venting machine shown in Fig. 6, which is provided with a two-pointed punch and corresponding dies. The cups are fed by hand on a revolving circular plate, at the rate of 70 per minute. The circular depression in the bottom of the cup, which serves as the receptacle for the percussion composition, is next made. The cups are fed through a vertical trough at the rate of 90 per minute. The trough has a flat pan at the top, into which the cups in quantities are emptied, and where they are arranged so as to present the proper end to the punch. The cups thus completed are well washed in an alkaline solution, to remove all traces of oil, and then thoroughly dried.

The percussion-composition consists of fulminate of mercury, 35 parts; chlorate of potash, 16 parts; glass-dust, 45 parts; gum-arabic, 2 parts; gum-tragacanth, 2 parts, by weight. These are mixed without danger by using the fulminate in a moist state, the water having been entirely drained from it. The chlorate of potash being well triturated, and the glass-dust properly prepared, the ingredients are put into a china bowl and thoroughly mixed, using a small steel spatula for the purpose. The dissolved gums will contain sufficient water to reduce the composition to a thick paste, it being used in the machine of this consistency.

Glass-dust for the percussion-composition is prepared for use in the following manner: Broken French plate-glass only is used. The glass is washed clean and dried; it is then broken into small pieces,

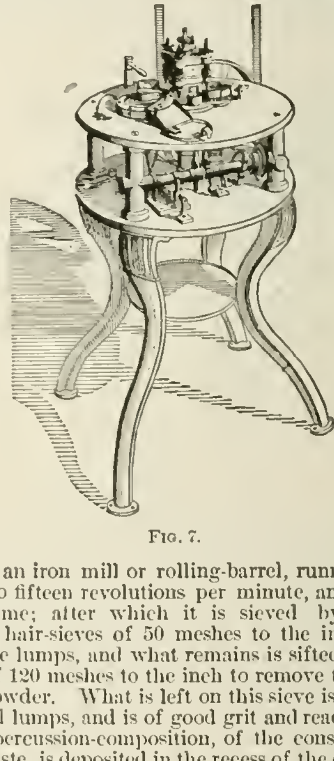


Fig. 7.

put into an iron mill or rolling-barrel, running from twelve to fifteen revolutions per minute, and ground for a time; after which it is sieved by shaking through hair-sieves of 50 meshes to the inch to remove the lumps, and what remains is sifted on hair-sieves of 120 meshes to the inch to remove the impalpable powder. What is left on this sieve is free from dust and lumps, and is of good grit and ready for use.

The percussion-composition, of the consistency of thick paste, is deposited in the recess of the cup by the priming-machine, a very ingenious piece of mechanism (shown in Fig. 7), which performs this important operation with the greatest accuracy and certainty, and with perfect safety. Its principal parts are, first, the central revolving spindle, with four tubular feeders at its head, which deposit the percussion-composition in the cups; second, the magazine on the right; and, third, the circular plate on the left, on which the unprimed cups are fed to the machine. The four tubular composition-feeders at the head of the spindle consist each of a small depending stem, down which a closely-fitting tube is made to slide, the lower edge projecting a little below the end of the stem. By the revolving motion of the spindle these tubular feeders are brought successively over the magazine and over the cups to be primed. At the moment a feeder is presented over the magazine, which is a shallow dish containing the percussion-composition, the magazine rises until its metal bottom is in contact with the tube, a slight shaking motion of the magazine during its progress serving to deposit compactly into the open projecting end of the tube a sufficient quantity of composition for the priming of a single cup. The magazine then recedes, while the revolving spindle

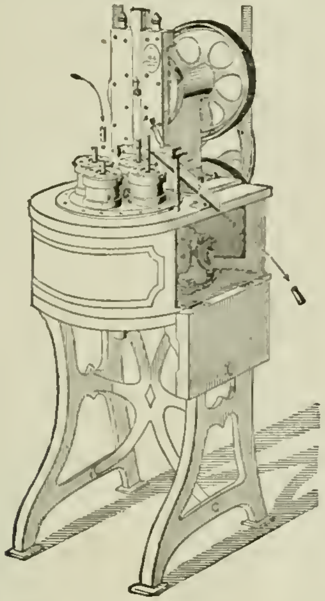


FIG. 8.

carries the charged feeder to the circular plate on the left, which presents the cups for priming. The motion of this plate is from left to right, while that of the spindle is from right to left, whereby the feeders and cups are made to meet and leave each other in opposite directions. The plate is provided with eight upright movable stems, on the ends of which the unprimed cups are fed. As the cups and feeders are brought, by the revolutions of the plate and spindle, in a vertical line with each other, the cups are raised by their stems so as to receive the percussion-composition exactly in their circular recesses from the tubes of the feeders. The tube, at the moment of contact with the cup, slides up its depending stem and frees the composition from its end, which is pressed by the upward motion of the cup snugly into the circular recess. The feeders and cups in parting leave each other horizontally in opposite directions, so that the percussion-composition is sheared off evenly and smoothly with the bottom surface of the cup. A specific quantity of composition is thus deposited in the recess of each cup at each operation. The principal difficulty heretofore encountered in perfecting a machine of this kind is entirely overcome by the use of this peculiar feeder. This machine primes at the rate of 38 per minute.

The tapering is performed in two operations: first, by forcing the shell through dies made in three cylindrical sections of graduated dimensions; second, while the composition is still moist in the circular recesses of the cups, the latter are put into the headed cases and crimped into position, the cases being tapered and reduced at the same time. The first operation prevents the case from wrinkling or folding; the second completes the tapering. The tapering-machine, shown in Fig. 8, consists of four vertical tapered dies, with stems projecting from their centers, on which the cases and cups are fed, the crimpers working from the sides of the dies, and the descending punch which forces the cases into the dies. The primed cups are placed on the ends of the stems projecting from the dies, and the cases are placed over them. By the revolution of the horizontal plate on which the dies are placed, each die is in succession brought under the descending punch, which forces the cases into the dies and presses their heads hard against the primed cups, while the crimpers move forward from the side and bite the cups snugly and firmly into place. The central stem rises out of the die as the latter leaves the punch, and the case is removed by a spring extractor. The section of the case which is to envelop the bullet is not tapered by the machine, but reduced to the form of a right cylinder whose inner diameter is the same as that of the bullet. This gives the bullet a securer hold in the case and helps to make the cartridge water-proof.

The United States elongated service-bullets are made by compression by means of machinery adapted to this purpose. They are uniform in size and weight, smoother and more homogeneous, more accurate, and give better results than cast and swaged bullets. The alloy for bullets should be pure soft lead of commerce, of specific gravity about 11.35, which is increased by pressure to about 11.45, and which melts at 600° Fahrenheit and volatilizes at red heat, and in proportion of 16 parts of lead to 1 of tin. The lead is first melted and skimmed of dross—amounting to 5 per cent in good lead—and cast in iron molds into cylindrical bars, .50 of an inch in diameter and 20 inches long. These bars are passed through rolls which reduce them to .38 of an inch in

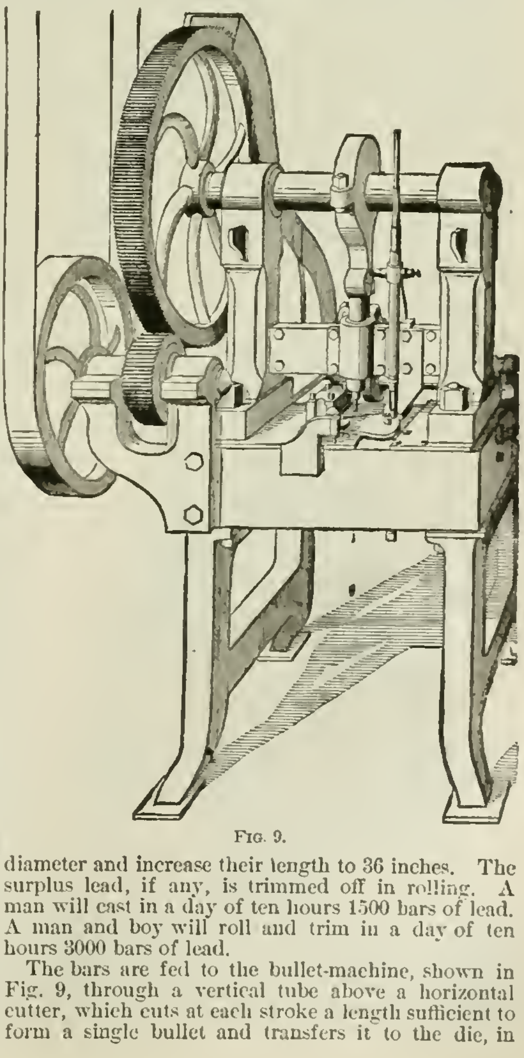


FIG. 9.

diameter and increase their length to 36 inches. The surplus lead, if any, is trimmed off in rolling. A man will cast in a day of ten hours 1500 bars of lead. A man and boy will roll and trim in a day of ten hours 3000 bars of lead.

The bars are fed to the bullet-machine, shown in Fig. 9, through a vertical tube above a horizontal cutter, which cuts at each stroke a length sufficient to form a single bullet and transfers it to the die, in which, by means of a vertical punch, the bullet is formed with its grooves. The surplus lead is forced out at the junction of the dies in the direction of the longer axis of the bullet, and at the junction of the punch and dies at its head. A bullet-machine will

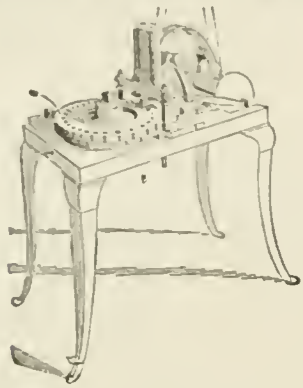


Fig. 10.

make in a day of ten hours about 25,000 to 27,000 bullets. Best lard-oil is used on the lead bars to lubricate the dies.

The operation of trimming the bullets is performed by the bullet-trimming machine shown in Fig. 10. The bullets are fed by hand into a revolving perforated circular plate, whence they are forced by a punch through trimmers which open from the point to the base of the bullet, and which conform to its shape, a cutter at the same time passing over the base. After this they are forced by the punch through the

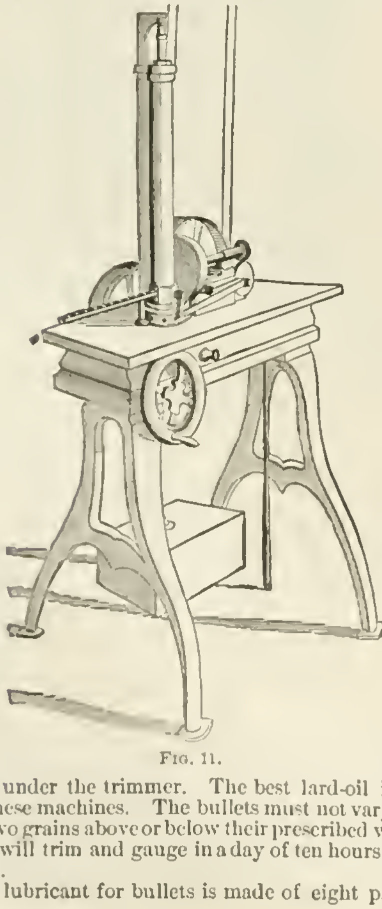


Fig. 11.

gauge under the trimmer. The best lard-oil is used with these machines. The bullets must not vary more than two grains above or below their prescribed weight. A boy will trim and gauge in a day of ten hours 15,000 bullets.

The lubricant for bullets is made of eight parts of bayberry tallow and one part of graphite, by weight. The latter must be of the best quality and free from grit. The bullets should be lubricated by machinery whenever possible, as the grooves are more surely and completely filled and more closely packed by mechanical pressure. Experiment has shown that one of the best lubricants for use with the gun, and in the lubricating machine, is Japan wax. It gives a very small per cent of fouling and works freely in the machine. It is generally cheaper than the above lubricant and has been in use several years.

The lubrication of the bullet is done by the lubricating-machine shown in Fig. 11. The lubricant is molded into cylinders of about 10 inches in length. These cylinders are fed to the machine through a vertical tube, pressure being applied to keep the supply constant. The bullets are placed by hand in a perforated revolving vertical plate and forced by a punch through a sizing-die fixed in the bottom of the tube, which is pierced with small holes. The lubricant is forced through these holes into the grooves of the bullet, filling them completely. In cold weather an arrangement for slightly warming the lubricant should be provided. A boy will lubricate in a day of ten hours 15,000 bullets.

The cases are now loaded with powder and bullets by means of the loading-machine, shown in Fig. 12, which consists of a revolving circular plate with holes or receivers, and a hopper and powder-measure. The cases and bullets are fed on revolving plates, 35 a minute; the former are lifted into the receivers, passed well under the hopper and measure for a charge of powder, and then under the bullet-feeder for a lubricated bullet. In order to insure a full charge in each cartridge, the machine is provided with a bell, which gives notice to the operative of any failure in this particular. The edge of the case is then crimped on the bullet in a very simple manner. The receivers are smaller at the top where the bullet enters than at the bottom where the case is received, the diameter of the former being only equal to that of the interior of the open end of the latter. After the bullet has been pressed into the case, the cartridge is lifted so that the edge of the case is forced into the conical surface of the receiver between its larger and smaller diameters. The powder is placed in a pasteboard hopper, about two feet above the machine, and is fed to the cases through a paper tube one inch in diameter; the hopper and tube stand inside of a large conical shield of boiler-iron.

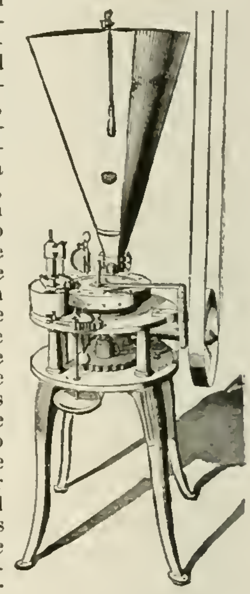


Fig. 12.

During the process of manufacture, accidents are only possible with the loading-machine; and every precaution is taken to provide against their occurrence. As the machine is now made and arranged, the explosion of one cartridge may communicate fire to the few charged cases near it without danger. The entire charge of powder in the hopper may be thus exploded without the possibility of injury, either to the operative or to the machine, as the hopper and tube offer but a slight resistance to the action of the gases that expand their forces in every direction without affecting the stability of the protecting shield. This has been proved by experimentally exploding full charges of two and a half pounds in the hopper itself. But the explosion of a cartridge in the operation of loading is of very rare occurrence. Out of the many millions loaded at Frankford Arsenal in the past ten years, a trifling number only have exploded prematurely, resulting in no damage whatever. After loading, the cartridges are wiped clean and put up in paper packages and packed in wooden boxes for storage or issue.

The cartridges are put up in paper boxes holding 20 rounds. Each box is arranged for two rows of 10, the rear row being higher than the front, each alternate cartridge having its rim below that of the other, for facility in loading and close packing. The frames and skeleton divisions of the boxes are made of straw-boards, the shapes of each part being cut with punches and dies, and such as reqnire it being creased for folding. The frame of the box is covered with stout paper bearing a printed description of the contents, and projecting far enough over to paste down the lid securely. For convenience in opening the box, a piece of strong twine is fastened at one end of the box and pasted along the inside of the seam of the lid, the loose end projecting a few inches.

The cartridges are packed, for storage or transportation, in wooden boxes, containing fifty packages each. These ammunition-boxes are painted, and the description of contents is stencil-marked on the ends, the date of fabrication branded on the sides, and the place of fabrication on the interior of the lid. See *Cartridge*.

CENTERING.—1. In consequence of windage, which is necessary for all muzzle-loading guns, the axis of the projectile does not always coincide with that of the bore; in firing, this leads to inaccuracy of fire. In order to secure accuracy of fire, it is essential that the axis of the projectile should correspond with that of the bore of the gun, for otherwise the axis of rotation will be variable and the deflection of the projectile uncertain. Should the axis of the projectile on leaving the bore be unsteady, the projectile will have the wabbling motion so frequently observed in experimental practice. A projectile is said to be centered when the grooves of the rifling are so constructed as to bring the axis of the projectile in line with that of the bore when the piece is fired. Centering may embody the compressing or expanding systems in any required degree. While the projectile is rotated by the solid projections formed upon it, and fitting into the grooves of the gun, the exterior of these projections, or of the whole projectile, may be covered with a soft substance which may, in the case of a breech-loader, be larger than the bore, and thus be compressed while passing out of the gun; or which may be expanded, by the pressure of the powder, to fill the gun. When the projectile is well centered, windage cannot affect its straight passage through the bore.

2. The framework upon which an arch or vault of stone, brick, or iron is supported during its construction. The simplest form of centering is that used by masons and bricklayers for the arches of common windows and doors. This is merely a deal board of the required shape, upon the curved edge of which the bricks or stones of the arch are supported until they are keyed in. In building bridges or other structures where arches of great span are to be constructed, the centering is usually made of framed timbers, or timbers and iron combined. The arrangement of the timbers should be such that the strain upon each shall be mainly a thrust in the direction of its length, for if the strain were transverse, a comparatively slight force would snap it, and if a longitudinal pull, the whole structure would be no stronger than the joints holding the pieces of timber together. In arches of great span, such as that of the Waterloo Bridge, London, a longitudinal pulling strain is almost inevitable in some parts, as a beam of great length would bend to some extent under a thrusting strain. In such cases great skill and care are demanded in the designing and construction of the joints. As an arch is built from the piers towards the keystone, the weight upon the haunches during construction tends to push the crown upwards, and therefore the problem of designing a framed centering involves the resistance of this tendency, as well as the supporting of the weight of the materials. The centering of the Waterloo Bridge, designed by Rennie, presents a fine example of the fulfillment of these requirements. It will be easily seen that a weight upon two parts equidistant from the center will be resisted by direct thrust upon the beams passing obliquely downwards from these parts; one of each pair of these oblique beams thrusts outwards, and is directly supported by the abutments; the other thrusts inwards towards the center, the yielding of which is prevented by the longitudinal pull of the lower and longer oblique beams. In this and other modern structures cast-iron shoes have been successfully used for the tying-joints subject to the longitudinal pulling strain. The flexible centering, so called from its yielding at the joints, and varying its form with the load put upon it, is now abandoned. It was chiefly used by French engineers. That of Perronet for the bridge of Neuilly is a celebrated example. Occasionally, when a very great span is required, and the navigation will permit, piers are built, or piles are driven, to support the centering, and the design is much simplified thereby.

Among the bridges of antiquity, that built by Trajan over the Danube is considered to have been the most magnificent; it was erected on 30 piers, of 150 feet in height, and the opening from one pier to another was 170 feet wide; the piers of this fine bridge are still to be seen on the Danube, between Servia and Moldavia, a little above Nicopolis. In the United States there are, as yet, comparatively few stone bridges of great size; the magnitude of our rivers, the heavy expense, as well as the amount of time required for the erection of such structures, being ill adapted to the pressing wants of the country; but the wrought-iron and suspension-bridges built of late years in this country rank among the most remarkable in existence. In suspension-bridges the flooring or main body of the bridge is supported by strong iron chains or rods, hanging in the form of an inverted arch from one point of support to another. The points of support are the tops of strong pillars or small towers erected for the purpose.

CENTERING-MACHINE.—A form of machine used in gun-construction for centering shafts, bolts, etc. The purposes are various, but especially to make such a depression at the exact center that the object may be placed in a lathe for turning, Fig. 1 shows

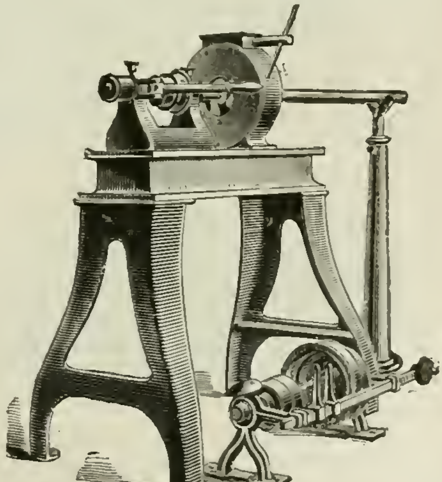


Fig. 1.

the Hyde centering-machine, which is provided with a chuck (enlarged in Fig. 2), especially designed for centering purposes. The jaws, which are very wide and heavy, are firmly supported on both sides. A steel stud ¾ of an inch in diameter passes through the jaw and each side of the case. The jaws are faced with best quality tool-steel and thoroughly hardened. In holding stocks of different sizes, the chuck is so constructed that the line of contact of the jaws moves from a point near their ends towards the fulcrum-studs, as the work to be held increases in diameter,

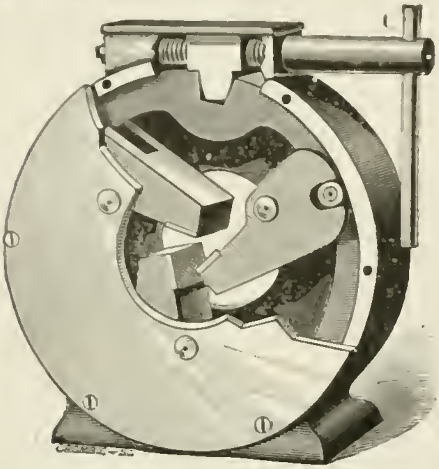


Fig 2.

thereby giving greater leverage and holding power for heavy work and distributing the wear over the whole surface of the jaws. Another important point in securing the continued accuracy of this chuck lies in the fact that the wear of the screw does not in any way affect the accuracy of the jaws. The drill-spindle slides through the cone and is operated by a lever having a toothed segment connected through a pinion with a rack cut on the box which slides in the headstock. This gives a quicker and much more desirable feed to the drill than the ordinary screw-feed. Both bearings of the live spindle are large and long and made of the best hard bronze metal. The machine will center all sizes of round stock from ¼ of an inch to 4½ inches, and is provided with an adjustable stand for supporting long bars.

Fig. 3 shows the Pratt and Whitney 8 inch Double Cutting-off and Centering Machine, used for axles and shafts of any length and diameter to 8 inches. The shafts revolve in self-centering jaws, adjustable by rack and pinion to any position on the bed, and are driven by cone and double gearing giving three changes of speed, any of which may be quickened as the cutting tools approach the center of the shaft, the number of speeds being thus increased to six. Tool-slides may be adjusted by rack and pinion to any length of shaft, and operated separately or together, each having three changes of power-feed; also rapid hand-movement quickly changed from hand to power feed. The centering-heads, with revolving spindles driven by a separate countershaft, slide on the tool-carriages.

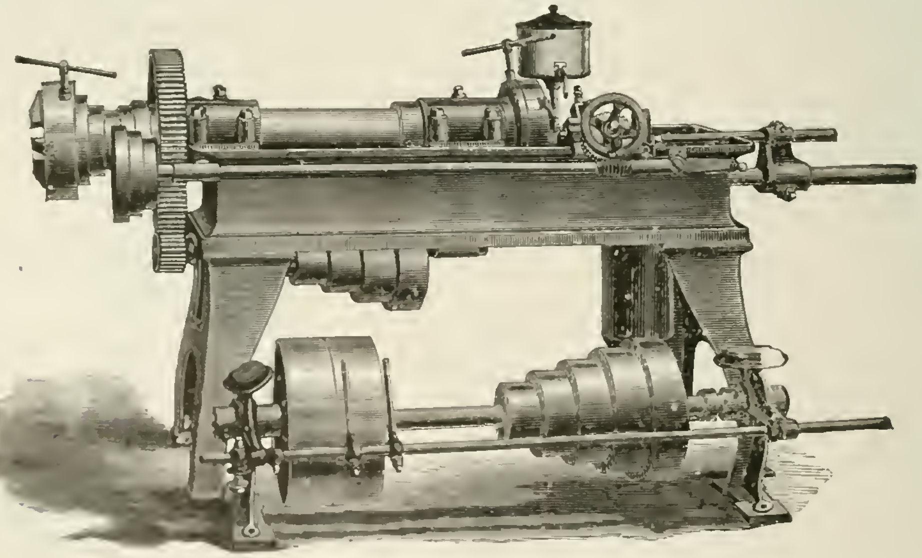


Fig. 3.

CENTER OF AN ARMY.—The body of troops occupying the place in the line between the wings.

CENTER OF FIGURE.—The point on which a plane figure or plane surface would balance, supposing their areas to have weight. This point is so situated that all straight lines passing through it, and terminated by the superficies of the figure or surface, are bisected in it.

CENTER OF GRAVITY.—That point in a body, or system of bodies rigidly connected, upon which the body or system acted upon only by the force of gravity will balance itself in all positions. Though the action of gravity enters this definition, many of the properties of the point are independent of that force, and might be enunciated and proved without conceiving it to exist. By some, accordingly, the point has been called the *center of magnitude*, and by others the *center of parallel forces.* Such a point exists in every body and system, and only one such point. Every body may be supposed to be made up of a multitude of minute particles connected by cohesion, and, so far as its balance under gravity is concerned, each of these may be supposed to be removed, and its place occupied by a force proportioned to its weight. Instead of the body, on these suppositions, we should then have a system of parallel forces, the lines from the various particles to the earth's center being regarded as parallel. But a system of parallel forces has a single resultant acting through a fixed point, whose position is independent of the position in space of the points of application of the component forces, provided their relative positions in the system continue unchanged. This point is the center of gravity; and if it be supported, it is clear that the body will balance itself upon it in all positions. The same reasoning obviously applies to any system of bodies rigidly connected. It is usual to demonstrate this and the general rule for finding the center of gravity by proving it first in the case of two heavy particles forming a body or system, and then extending the proof to the case of any number of particles. Let P and Q, Fig. 1, be two heavy particles. Join P and

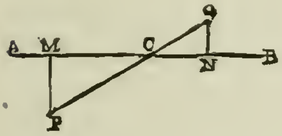


FIG. 1.

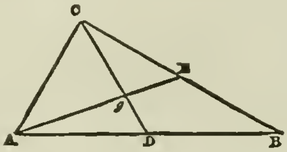


FIG. 2.

Q, and divide the line PQ in C, so that weight of P : weight of Q : : CQ : CP. Then C will be the center of gravity of P and Q. Draw ACB horizontal, and PM, QN vertical, meeting AB in M and N. Then if P and Q represent the weights of P and Q, we have P : Q : : CQ : CP. But CQ : CP : : CN : CM by similar triangles. Therefore P : Q : : CN : CM, and P . CM = Q . CN. P and Q, therefore, are balanced about C. This is true in all positions of P and Q, for no assumption was made as to their positions. C, therefore, is their center of gravity. Also, we may conceive P and Q to be removed, and in their stead a particle at C equal to them taken together in weight. If, now, the system contained three, it is clear how we should proceed to find its center of gravity; having found the center of gravity of two, we should consider the system as formed of two—viz., the equivalent of the first two at their center of gravity, and the third, when the case would fall under that already treated; and so on, extending the rule to a system containing any number of particles. Apart from this rule, however, it is possible, in the case of most regular homogeneous bodies, to fix upon their centers of gravity from general considerations. The center of gravity of a straight line, for instance, must clearly be in its middle point. So the center of gravity of a uniform homogeneous cylinder must be in the middle point of its axis. It must be in the axis, for the cylinder clearly is equally balanced about its axis. It must also be somewhere in its middle circular section, for it will balance itself on a knife-edge under that section. It must, therefore, be in the point where that section cuts the axis, or in the middle of the axis. The center of gravity of a uniform material plane triangle may be found from similar considerations. The triangle ABC, Fig. 2, may be supposed to be made up of uniform material lines parallel to its base, AB; each of these will balance upon its middle point. The whole triangle, therefore, will balance upon the line CD, which bisects the base AB and all lines parallel to it. In the same way the triangle will balance upon the line AE, bisecting BC. But if a figure balances itself upon a line, its center of gravity must lie in that line. The center of gravity of the triangle is therefore in CD, and also in AE. It must therefore be at g where these lines intersect, g being the only point they have in common. Now, by geometry, we know that g divides CD, so that $Cg = \frac{2}{3}CD$. Hence the rule for finding the center of gravity of a triangle: Draw a line from the vertex, bisecting the base, and measure off Cg, two thirds of the line. g is the center of gravity. By a similar method the center of gravity of a great number of figures may be determined. The above method applies only where the figure of the body is regular and its mass homogeneous. But many bodies, besides being irregular, are formed by the agglomeration of particles of different specific gravities. Of these, the center of gravity can be found only by experiment, though not always satisfactorily. Let the body be suspended by a string, and allowed to find its position of equilibrium. The equilibrium being due to the tension of the string counterbalancing gravity, it follows that the tension is in the same line with that on which gravity acts on the body. But the tension acts on the line of the string, which therefore passes through the center of gravity. Mark its direction through the body. Suspending it then by another point, we should ascertain a second line in which lies the center of gravity. The center of gravity, then, must be where these lines intersect.

The determination of the center of gravity is a matter of great importance in cannon, both for mechanical maneuvers and for ordinary handling. In all the large guns in the United States, and in many in Europe, the axis of the trunnions passes through the center of gravity of the gun. Such guns have no preponderance, and need no support when firing except the trunnions. This innovation was introduced by the genius of Rodman, and brought many advantages in the handling of heavy guns. In projectiles the center of gravity is also a thing of moment. Spherical projectiles, in which this point does not coincide with the center of figure, are said to be eccentric and are subject to certain deviations. Regarding the gun as a solid of revolution whose axis coincides with that of the bore, the position of the center of gravity is determined from the principle that the sum of the moments of the weights of the several parts is equal to the moment of the weight of the entire piece. For convenience, the plane of reference is usually taken either at the knob of the cascabel and perpendicular to the axis of the bore, or as coincident with the front face of the piece. The general formula expressing the above relation is

$$W\,x = w^{i}\,x^{i} + w^{ii}\,x^{ii} + w^{iii}\,x^{iii} + w^{iv}\,x^{iv} + \text{etc.},$$

or

$$x = \frac{w^{i}\,x^{i} + w^{ii}\,x^{ii} + w^{iii}\,x^{iii} + w^{iv}\,x^{iv}}{W}, \ldots (A)$$

in which W = the weight of the entire piece; x = the distance of its center of gravity from the plane of reference; w^{i}, w^{ii}, w^{iii}, etc. = the elementary weights; those corresponding to cavities (as the bore, chamber, etc.) being regarded as negative; x^{i}, x^{ii}, x^{iii}, etc. = the distances of their respective centers of gravity from the plane of reference. Should the gun be homogeneous throughout, the unit of weight may be canceled from the second member of equation (A), in which case it will be necessary to operate with the volumes simply, instead of the weights. In guns of a curved exterior, like those of the Rodman model, it is customary to divide the gun up by a system of parallel planes, at right angles to the axis, and in numbers such that the elementary volumes thus formed shall closely approximate some regular geometrical figure, usually the conic frustum, of which the volume and the position of the center of gravity admit of ready calculation. When the gun is to be without preponderance, i.e., when the axis of the trunnions is to pass through the center of gravity, the weights of the trunnions and rimbases may be omitted, since they will be symmetrically disposed about that axis. Where it is desired that the gun shall have a certain preponderance, the position of the axis of the trunnions in front of the center of gravity of the gun is determined as follows: The weight of the piece is supported by the elevating device and the trunnions. The pressure on the elevating device and its distance from the center of gravity are known; therefore the distance which the trunnions should be placed in front of the center of gravity to support the remainder of the weight will become known from the proportion $p : (W - p) : : Y \; l$, in which p represents the preponderance; l, the distance of the point of attachment of the elevating device from the center of gravity; $(W - p)$, the weight to be sustained by the trunnions; and Y, the distance of their axis from the center of gravity. See *Centrobaric Method* and *Distorted Section*.

CENTER OF GYRATION.—The point at which, if the whole mass of a body rotating round an axis or point of suspension were collected, a given force applied would produce the same angular velocity as it would if applied at the same point to the body itself. The center of gyration bears a strong analogy to the center of oscillation. The cases differ only in this, that in the latter the operating forces are supposed to act at every point of the moving body, while in the former there is only one force acting upon one point. The center of gyration is found by the following rule: Divide the moment of inertia of the rotating mass by the mass of the body, and extract the square root of the quotient. The result is the distance of the point from the axis of rotation. The moment of inertia, it may be stated, is the sum of the products of the weight of each point of the mass by the square of the perpendicular distance of that point from the axis.

CENTER OF IMPACT.—The *mean point of impact*, or the mean of all the hits, when a projectile strikes a target a number of times. It is a point of the mean trajectory. See *Point of Impact*.

CENTER OF OSCILLATION.—Referring to the article PENDULUM, it will be seen that the time of a pendulum's vibration increases with its length, being always proportioned to the square root of its length. This is strictly true only of the simple pendulum, in which the pendulous body is supposed to have no determinate magnitude, and to be connected with the point of suspension by an inflexible wire without weight. If, however, the vibrating body have a determinate magnitude, then the time of vibration will vary, not with the square root of its length, but with the square root of the distance from the axis of suspension of a point in the body called its center of oscillation.

If each part of the vibrating body were separately connected with the axis of suspension by a fine thread, and entirely disconnected from the rest of the body, it would form an independent simple pendulum, and oscillate as such—the time of each vibration being as the square root of the length of its thread. It follows that those particles of the body which are nearest to the axis of suspension would, as simple pendulums, vibrate more rapidly than those more remote. Being connected, however, as parts of the solid body, they vibrate all in the same time. But this connection does not affect their *tendencies* to vibrate as simple pendulums, and the motion of the body which they compose is a compromise of these tendencies of its particles. Those nearest the axis are retarded by the more remote, while the more remote are urged on by the nearer. Among these particles there is always one to be found in which the accelerating and retarding effects of the rest are mutually neutralized, and which vibrates in the same time as it would if it were unconnected with the other parts of the body, and simply connected by a fine thread to the axis of suspension. The point in the body occupied by this particle is its center of oscillation. By this center of oscillation the calculations respecting the vibration of a solid body are rendered as simple as those of a molecule of inconsiderable magnitude. All the properties which belong to a simple pendulum may be transferred to a vibrating body of any magnitude and figure, by considering it as equivalent to a single particle of matter vibrating at its center of oscillation.

The determination of the position of the center of oscillation of a body usually requires the aid of the calculus. It is always further from the axis of suspension than the center of gravity is, and always in the line joining the center of gravity and the point of suspension, when the body is suspended from a point. The rule for finding it in such a case is: If S be the point of suspension, and O the center of oscillation, $SO = \frac{\Sigma(md^2)}{M \cdot Sg}$; or it is the quotient obtained by dividing the moment of inertia of the body by the product of its mass into the distance of its center of gravity from the point of suspension. See *Pendulum*.

CENTER OF PERCUSSION.—The center of percussion of a body or a system of bodies revolving about a point or axis is that point in it which striking an immovable object, the whole mass shall not incline to either side, but rest, as it were, in equilibrio, without acting on the center or axis of suspension. If the body be moving freely, then the center of percussion is that point in it at which its whole impetus is supposed to be concentrated. In this case, if the body struck with its center of percussion an immovable obstacle, and if it were perfectly rigid and inelastic, it would come to perfect repose; whereas, if it struck the obstacle with any other point a rotatory motion would be produced in it. When the body is moving freely, and there is no rotatory motion, the center of percussion coincides with the center of gravity. If the body be moving round a point or axis of suspension, the center of percussion coincides with the center of oscillation. The more complicated case of a body rotating round an axis within it would require, for its explanation, analytical formulæ which cannot conveniently be translated into ordinary language. There are many positions which the axis may have in which there will be no center of percussion—i e., there will be no direction in which an impulse could be applied without producing a shock upon the axis. One case of this sort is that of the axis being a principal axis through the center of gravity.

CENTER OF PRESSURE.—The center of pressure of any surface immersed in a fluid is the point in which the resultant of the pressures of the fluid on the several points meets the surface. When the bottom of a vessel containing fluid, or when a plane immersed in fluid, is horizontal, a pressure on every point of it is the same, being that due to the weight of the column of fluid standing above the bottom or plane. In either case the pressures at the different points obviously form a system of equal parallel forces, whose center will be the center of gravity of the bottom or plane, their resultant passing through this point being the sum of all their forces. But when the plane is inclined at any angle to the surface of the fluid, the pressure is not the same at all points, but is obviously greater at the lower than at the upper points, for the lower have to support taller columns of the fluid. The resultant of these forces, then, will not pass through the center of gravity of the surface, but through a point below it. This point is the center of pressure, and evidently will lie below the center of gravity for all fluids in which the pressure increases with the depth. If the surface pressed upon form part of the containing vessel, and be supposed movable, it will be kept at rest by a pressure equal to the sum of the fluid pressures applied at the center of pressure, and acting in the opposite direction. In the case of a vessel with a parallelogram for one side, the center of pressure is at the distance of one third of the height from the bottom. In the case of a triangular vessel whose base is at the bottom, it is one fourth of the height only.

CENTER OF THE BASTION.—In fortification, the intersection made by two demi-gorges.

CENTER-PINTLE CARRIAGE.—One in which the chassis is attached to the pintle at its middle, and revolves around it through the entire circumference of the circle. The traverse-circles are consequently continuous. By this arrangement a much greater horizontal field of fire is secured.

CENTESIMATION.—In ancient military history, a mild kind of military punishment in cases of desertion, mutiny, and the like, when only every one hundredth man was executed.

CENTRAL FORCES.—Those forces which cause a moving body to tend towards some point or center, called the center of force or motion. The doctrine of central forces has for its starting-point the first law of motion—viz., that a body not acted on by any external force will remain at rest, or move uniformly in a straight line. It follows from this law that if a body in motion either changes its velocity or direction, some external force is acting upon it. The doctrine of central forces considers the paths which bodies will describe round centers of force, and the varying velocity with which they will pass along in these paths. It investigates the law of the force round which a body describes a known curve, and solves the inverse problem, and many others, the general statement of which could convey no clear idea to the unmathematical reader. As gravity is a force which acts on all bodies from the earth's center, it affords the simplest general illustration of the action of a central force. If a stone be slung from a string, gravity deflects it from the linear path which it would otherwise pursue, and makes it describe a curved line which we know would, in vacuo, be a parabola. Again, the moon is held in her orbit round the earth by the action of gravity, which is constantly preventing her from going off in the line of the tangent to her path at any instant, which she would do, according to the first law of motion, if not deflected therefrom by any external force. To that property of matter by which it maintains its state of rest or motion, unless acted upon by other matter, has been given the name *inertia*.

We will now explain how, through the action of a central force, a body is made to describe a curved path. Suppose it to have moved for a finite time, and conceive the time divided into very small equal parts; and instead of the central force acting constantly, conceive a series of sudden impulses to be given to the body in the direction of the center, at the end of each of the equal intervals, and then observe what, on these suppositions, will happen. Let S, Fig. 1, be the center, and let the original motion be

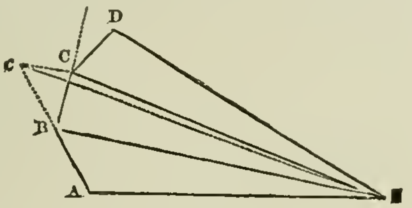


FIG. 1.

from A, on the line AB, which does not pass through S. In the first interval the body will move with a uniform velocity, say from A to B. In the second, if acted on by no force, it would move on in AB produced to *c*, B*c* being = AB. But when it arrives at B it receives the first sudden impulse towards S. By the composition of velocities, it will move now with a new but still uniform velocity in BC instead of B*c*, BC being the diagonal of the parallelogram of which the sides represent its impressed and original velocity. Having reached C at the end of the second interval, it receives the second impulse towards S. It will now move in CD instead of in BC produced. If, then, we suppose the periods of time to be indefinitely diminished in length, and increased in number, the broken line ABCD will become ultimately a continuous curve and the series of impulses a continuous force. This completes the explanation.

Going back, however, on our suppositions, we may here establish Newton's leading law of central forces. That the body must always move in the same plane results from the absence of any force to remove it from the plane in which at any time it may be moving. The triangles ASB and BSC are clearly in the same plane, as the latter is on that in which lie the lines B*c* and BS. Also, since the triangles ASB, BS*c* are equal, being on equal bases, AB, B*c*, and triangle BSC = triangle BS*c*, as they are between the same parallels, *c*C and BS, it follows that ASB = BSC. So BSC = CSD; and so on. In other words, the areas, described in equal times by the line (called the radius vector) joining the center of force and the body, are equal. As this is true in the limit, we arrive, by the composition of the small equal areas, at the law that the areas described by the lines drawn from the moving body to the fixed center of force are all in one plane, and proportional to the times of describing them. Very few of the laws of central forces are capable of being proved like the preceding, without drawing largely on Newton's lemmas, with which we shall not suppose the reader to be acquainted.

We have shown that a body continually drawn to a center, if it has an original motion in a line that does not pass through the center, will describe a curve. At each point in the curve it tends, through its inertia, to recede from the curve, and proceed in the tangent to it at that point. It always *tends* to move in a straight line in the direction in which it may at any time be moving, and that line, by the definitions of a tangent and of curvature, is the tangent to the curve at the point. At the point A, Fig. 2, it will endeavor to proceed in AD: if nothing hindered it, it would actually proceed in that line, so as, in the time in which it describes the arc of the curve AE, to reach the point D, and thus recede the length DE from the curve; but being continually drawn out of its direction into a curve by a force to a center, it falls below the point D by the distance DE. The force which draws it through this distance is called the centripetal force, and that which would make it recede in the same time through the distance DE from the curve is called the centrifugal force. It may be remarked that the centrifugal force is not, like the centripetal, an impressed or external force acting on the body. It is simply the assertion of the body's inertia under the circumstances produced by the centripetal force.

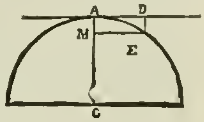


FIG. 2.

Many familiar illustrations will occur to the reader of the action of what is called the centrifugal force. A ball fastened to the end of a string, and whirled round, will, if the motion is made sufficiently rapid, at last break the string and fly off. A glass of water may be whirled so rapidly that, even when the mouth is pressed downwards, the water will still be retained in it, by the centrifugal force pressing it up against the bottom of the glass. The centrifugal action will be found to increase with the velocity. In all cases of a body moving in a circle, the force, it can be proved, varies as the square of the velocity of the body at the moment, and in the inverse ratio of the radius. As in this case the velocity varies as the radius inversely, it follows that the force is as the inverse cube of the radius. As in the case of circular motion the body always is at the same distance from the center, it follows that the centrifugal and centripetal forces are equal at all points of a circular orbit. The general law for all orbits is, that the centrifugal force varies as the inverse cube of the distance from the center. As the attractive force of gravitation varies as the inverse square of the distance, it may hence be shown that the centrifugal force gives perfect security, notwithstanding the constant attraction of the sun, that the planets, so far as that attraction is concerned, will never fall into the sun. See *Falling Bodies*, *Force*, and *Gravity*.

CENTRALIZATION.—In military affairs, a system of organization or of administration by means of which all matters appertaining to the army are directed by one center. The legitimate application of the term is to a state of change from local to central management, and therefore the opposite of localization. The system, when adopted in the administration of an army, is very dangerous, as it takes away the independence of action of the different officers under the Commander-in-Chief, and leads to favoritism; and should the mainspring of the machine break down, all the works come to a standstill. In England, the administrative military authority, although centralized in the Crown, has been placed under the control of Parliament, and there is nothing done under the orders of the War Office for which the Secretary of State for that Department may not at any time be called to account by Parliament.

CENTRICAL RIFLING.—The solid projectile, fitted to the rifling of the gun so as to center itself, has been improved by the *centrical* system, so called because of the peculiar mode of centering its simple iron projectile, which, instead of inclining towards the bottom of the bore in its passage out, is centered on its rounded bearings, without jar by the first pressure of the elastic fluid. This is effected by the peculiar curves of the shoulders of the three grooves, which incline towards the center of the bore, and thus form three rails for the projectiles to slide out upon without being compressed or strained. In case of large calibers with heavy projectiles, a shallow shoulder is taken out for the shot to turn against in loading. It is readily seen how rounding the groove prevents the violent shock of the projectile when its bearing-edges strike the rifling. The projection, *a*, bears and remains

upon the side, *d*, of the groove going in, and so leaves the windage, *c*, on the other side. In going out, the projectile will have acquired considerable velocity before it strikes the side, *c'*, so that the blow will be violent, and the commencement of the rotation instantaneous. The projection not only slides up the rounded groove without a blow, but lifts the projectile into the center of the bore, thus centering it. See *Scott Rifling*.

CENTRIFUGAL GUN.—A form of machine-gun, in which balls are driven tangentially from a chambered disk rotating at great speed.

CENTROBARIC METHOD.—The method ordinarily used to determine by calculation the center of gravity of a projected gun. The principle used is that the volume generated by any surface in revolving about a fixed axis is measured by the product of the surface into the path described by its center of gravity. The moments of the weights of the several parts are referred to an axis usually taken tangent to the knob of the cascabel. The sum of these moments, divided by the weight of the piece, gives the distance of the center of gravity from the assumed axis. In homogeneous guns the volumes of the several parts can be used instead of the weights.

CENTURION.—A Roman infantry officer who originally commanded a hundred men, but afterwards an indefinite number. They were of two grades, and were chosen by the Tribunes. Their duties were to drill the soldiers and appoint them tasks; and they had power to punish for minor offenses.

CENTURY.—In an ancient military sense, the hundred soldiers, who were employed in working the battering-ram.

CERCELEE.—In Heraldry, a cross circling or curling at the ends, like a ram's horn. Also written *Recercle*. See *Heraldry*.

CERCLE.—A form observed under the old government of France, by which it was directed that every evening at a specific hour the Sergeants and Corporals of brigade should assemble to receive orders, the former standing in front of the latter. Subsequent to the grand cercle, a smaller one was made in each regiment, when general or regimental orders were again repeated to the Sergeants of each regiment, and from them communicated to the officers of the several companies.

CEREMONIES.—Stated military performances, such as Parades, Reviews, Inspections, Escorts of Color, Escorts of Honor, Funeral Honors, Guard-mountings, etc. In the United States army, at all Parades and Inspections of a battalion, the Field and Staff are dismounted; they are also dismounted at Review, unless the Reviewing-officer be mounted.

CERTIFICATE OF DEPOSIT.—Every person who has moneys of the United States in his hands or possession pays the same to the Treasurer, an Assistant Treasurer, or some public depositary of the United States, and takes his receipt for the same, in duplicate, and forwards one of them forthwith to the Secretary of the Treasury. The face of each Certificate should show, in writing, to what appropriation the deposit belongs, provided the depositor has such information as may be necessary to enable the depositary to state the same in preparing the Certificate for issue. The place, date, and amount of deposit, and the number of the Certificate, together with the appropriation, if specified, are noted on the account-current or other proper return upon which the depositor desires to be credited for the money.

As the Certificates of Deposit constitute an important check upon the transactions of the different Government depositaries, and are required at the Treasury Department at the earliest possible moment for verification with the accounts of said depositaries, the following regulations concerning their future disposition are prescribed, which, as they are based upon express provisions of law, are expected to be strictly complied with:

1. The originals of all Certificates of Deposit for the deposit of any and all public moneys of every character and description, *except as stated in the next succeeding paragraph*, should be forwarded to the Secretary of the Treasury immediately upon their issue by the depositors (not the depositaries), who, before transmitting them, should see that their amounts correspond with the amounts actually deposited by them.

2. Those issued to disbursing-officers for disbursing funds deposited to their own official credit, subject to the payment of their checks, and more properly called disbursing-officers' receipts, should be retained in their own possession; those issued for the transfer of funds from one Government depository to another should be forwarded to the Treasurer of the United States.

3. Certificates of Deposit issued to military officers, either on account of repayments, sales of public property, or otherwise, should be *in duplicate;* the duplicates to be retained by the depositors.

4. In no case are Certificates of Deposit required to be filed with accounts rendered by Government officers to the accounting officers of the Treasury Department, nor does such a disposition of any Certificates of Deposit secure to the officers transmitting them proper credits in their accounts. Credits are only given officers in the settlement of their accounts upon warrants, which warrants are issued by the Secretary of the Treasury, and based upon the original Certificates of Deposit. In taking credit in their accounts-current, however, for deposits made, officers should state specifically the date of the deposit, and the designation and location of the depository in which the deposit was made, as well as the source, etc. All original Certificates of Deposit in favor of military officers, the amounts of which are required to be listed and recorded in the offices of any of the Heads of the Bureaus of the War Department, will immediately upon their receipt—a record having first been made of them for verification with the proper depositary accounts—be forwarded to the Head of the respective Department to which the deposits pertain for designation of the proper appropriations.

CERTIFICATE OF DISABILITY.—Whenever a non-commissioned officer or soldier becomes unfit for the military service in consequence of wounds, disease, or infirmity, his Captain forwards to the Commander of the Department or of the army in the field, through the Commander of the regiment or post, a statement of his case, with a certificate of his disability, in duplicate, signed by the Senior Surgeon of the hospital, regiment, or post, according to the form prescribed. If the recommendation for the discharge of the invalid be approved, the authority therefor is indorsed on the Certificate of Disability, which is sent back to be completed and signed by the Commanding Officer, who then sends the same direct to the Adjutant General's Office. But under no circumstances is the certificate given into the hands of the soldier. In deciding upon applications for pension, reference is made to the Certificate of Disability for proper proof that the soldier is entitled under the law. Therefore, when it is a *probable* case for *pension*, *special care* must be taken to state the *degree* of disability—as ½, ⅓, etc.; to describe particularly the disability, wound, or disease; the extent to which it deprives the soldier of the use of any limb or faculty, or affects his health, strength, activity, constitution, or capacity to labor or earn his subsistence. The Surgeon adds from his knowledge of the facts and circumstances, and from the evidence in the case, his professional opinion of the cause or origin of the disability, and whether *in the line of duty* or not.

CERTIFICATE OF MERIT.—A certificate given by the President to enlisted men in the United States army, upon the recommendation of Commanding Officers. The certificates are awarded only for acts of extraordinary gallantry in presence of the enemy, which acts must be specific and certified to by an eye-witness, preferably the immediate Commanding Officer of the soldier. Good standing and undoubted courage in a soldier will also be required to entitle him to a Certificate of Merit. Recommendations for the Certificate of Merit must each be in behalf of only one person, and must contain a full description of the merits of the case. They must be forwarded through the regular channel, and indorsed with approval and recommendation by each Commander, especially the Regimental Commander. The extra pay granted on Certificate of Merit commences at the date of the act of gallantry for which the certificate is granted. This extra pay is two dollars per month while the soldier remains continuously in service. Certificates of Merit are not granted to persons not in the military service of the United States at the date of application for them. Should a soldier die before receiving a certificate conferred upon him, it will be deposited in the office of the Second Auditor of the Treasury for the benefit of his heirs. In case the soldier is discharged before the certificate is issued, it will be retained in the office of the Adjutant General until called for, when proof of the identity of the applicant will be required.

CERUSE.—The basis of white oil-paint and a *carbonate of lead*. It has several other names—krems, Nottingham white, flake-white, etc. Like all other preparations of lead, ceruse is liable to be acted upon by exhalations from sewers, or by anything which contains sulphuretted hydrogen, in which case it is changed to a dull and leaden hue. Neither will it bear to be mixed with any pigment containing sulphur, such as vermilion. It is supposed that the white oxide of zinc might be substituted for ceruse as a white pigment with advantage.

CERVELIERE.—A small bascinet anciently worn under the *heaume*. Now obsolete.

CESSATION OF ARMS.—An armistice or truce agreed to by the Commanders of Armies, to give them time for a capitulation, or for other purposes.

CESTUS.—The covering for the hands worn by Roman pugilists. It was originally nothing more than a leathern thong or bandage used to strengthen the fist; but in after years it was well covered with knots and nails, and loaded with lead and iron, etc., to increase the force of the blow. It was not uncommon for a pugilist armed with the cestus to dash out the brains or break the limbs of his antagonist. The Roman pugilist (*cestuarius*) was often represented in sculpture. This word is often and more correctly written *Cæstus*, from the Latin *cædere*, to slay.

CHAFF-CUTTER.—An implement now much used at cavalry posts and in the field for cutting hay and straw into half-inch lengths. The advantage of this consists not so much in facilitating mastication or digestion as in preventing animals from wasting their food. No small amount of mechanical ingenuity has been applied to the construction of chaff-cutters, the simplest and oldest kinds of which are mere hand-machines with a single large knife, the hay or straw being pushed forward in a trough or box, whilst others are driven by horse, steam, or water power, and are not a little complicated. See *Forage*.

CHAFFEE MAGAZINE-GUN.—This gun belongs to that system in which a fixed chamber is closed by a movable breech-block, sliding and rotating, and operated by a lever from below. On the inner surface of the receiver are two circular guides which enter grooves in the breech-block and over which the breech-block slides. The block is a single piece hollowed out to receive the hammer and the mainspring. At the front of the block is the firing-pin, limited in its motion by a screw. The breech-block is operated by a lever. The front of the lever is hinged to the front of the breech-block; its middle is hinged to two arms which are in turn hinged to the sides of the receiver. The hammer is cocked when the breech-block lever is thrown open by the pressure of the lever-hook on the face of the hammer, which forces the latter back until the nose of the sear—which is a part of the trigger—enters a notch. Reverse motion of the lever closes the block which is locked by a projection on the lever, entering a recess in the block and in the sides of the receiver. The extractor is not rigidly connected with the breech-block, but has a longitudinal motion along its side. It does not begin to draw the shell until the breech-block has moved to the rear nearly an inch, when a shoulder on the extractor strikes a corresponding one on the block, after which both move together. The object of the extractor projecting so far in front of the block is to support the cartridges as they leave the magazine on their way to the chamber. A shoulder on the bottom of the carrier serves as an ejector. Its effect is to rotate the empty shells through the opening in the bottom of the receiver to the ground. The magazine is in the butt-stock. The shape of the inner surface of the carrier at its front is such that the point of the cartridge as it leaves it is opposite the center of the chamber. An inclined rear surface of the carrier prevents the rear of the cartridge from rising while on its way to the chamber. When the lever is thrown open a spring at the front of the carrier causes its rear to descend opposite the mouth of the magazine. In this position it serves as a cartridge-stop, preventing the escape of other cartridges. There is no cut-off to the magazine, nor can there be, each motion of the lever being accompanied with a corresponding motion of the ratchet. As a single-loader, the piece is loaded through the carrier, the rear of which is opened by depressing the front; this should be done before the lever is opened. The trigger is locked by a set-screw when the piece is carried at full-cock. As a magazine-gun, three motions are necessary to operate, viz., opened, closed, fired. As a single-loader, four motions are necessary, viz., loaded, opened, closed, fired. The gun carries six cartridges in the magazine, one in the carrier, and one in the chamber. See *Magazine-gun*.

CHAFFEE-REECE MAGAZINE-GUN.—This arm, an improvement on the Chaffee magazine-gun, belongs to that system of bolt-guns in which a fixed chamber is closed by a movable breech-bolt sliding and rotating. The magazine is in the butt-stock. The cartridges are held in the magazine by two ratchet-bars, one fixed and the other sliding, and operated when the bolt is drawn back and closed. The magazine having been loaded, the bolt is thrown open and each tooth of the sliding-bar passes behind the head of the cartridge next in its rear. The closing of the bolt moves the ratchet forward, bringing each cartridge its own length further to the front. The cartridges are firmly held in position, so that they are not and cannot be in contact with each other, which is positive prevention from accidental explosions.

The frequent accidents and loss of life from premature explosions by magazine-arms induced many gun-mechanics, and among the number Mr. Chaffee, to undertake to invent a magazine-arm that should be free from that objection, and after several years in study and hard work, and a large outlay of money, he produced this arm, which, upon a test-trial, before a Board of Army Officers, has demonstrated the fact that he has succeeded in doing it. This arm can be used as a single-shooter until occasion requires the delivery of shots more frequently than would be possible if the arm had to be loaded after each discharge, when, by the turn of a button, seven extra charges will be available which can be delivered in four seconds or less. This makes a body of men with this arm a very formidable foe.

The employment of the Chaffee-Reece arm in the service will reduce to a considerable extent the necessity for machine-guns, which are considered most valuable in destroying a body of men closely packed; but men these days avoid bunching on the field, especially when machine-guns are liable to be trained to cover them. Troops armed with this gun have each a machine-gun, and are more capable of repelling a boarding party from a ship, or an assaulting column upon a military work, as they can be so disposed as to defend the entire space, instead of one or two points.

Much time and expense are devoted to the education of officers of a well-organized army, and they have lived in vain if they know no better than to put dangerous arms in the hands of troops, who, having confidence in the knowledge of, and trusting all such questions to, the officers, as they, the soldiers, are obliged to do, move forward at their command with the risk of disaster from the fire of the enemy, but with no expectation that they are really in more danger from the arms with which they are fighting than from those in the hands of the opposing army.

The art of war is now reduced to a science by all well-regulated governments, and perhaps there is no branch of the service by which troops are asked to take so much risk as to use an arm which is liable to explode prematurely and either kill or maim for life the soldier whose services are necessary for the success of the cause, and in upholding the flag under which he takes service with confidence that he will be armed with a gun with which to kill the enemy, and not himself or his comrades. See *Chaffee Magazine-gun.*

CHAIN.—A device consisting of several associated links, joined endways, so as to string out in line. The varieties of chains are numerous, and their names are derived from their material, structure, or purpose. In mechanical maneuvers, and in the general work of the foundry and construction-shops, chains are indispensable. Chain-cables are made of links the length of each of which is generally about six diameters of the iron of which it is made, and the breadth about three and a half diameters. In government contracts, chain-cables are required to be made in 12½-fathom lengths, with one swivel in the middle of every alternate length, and one joining-shackle in each length. The stay-pins, to strengthen the links, are of cast-iron. The bar or rod from which each link is made has the two ends cut diagonally; it is bent into the form of a nearly complete oval ring; and then the two ends are joined and welded, the stay-pin being at the same time introduced at the proper place. Besides the ordinary links, there are end-links, joining-shackles, splicing-tails, mooring-swivels, and bending-swivels. The sizes of chain-cables are denoted by the thickness of the rod-iron selected for the links. The following table gives certain ascertained quantities concerning the cables in ordinary use :

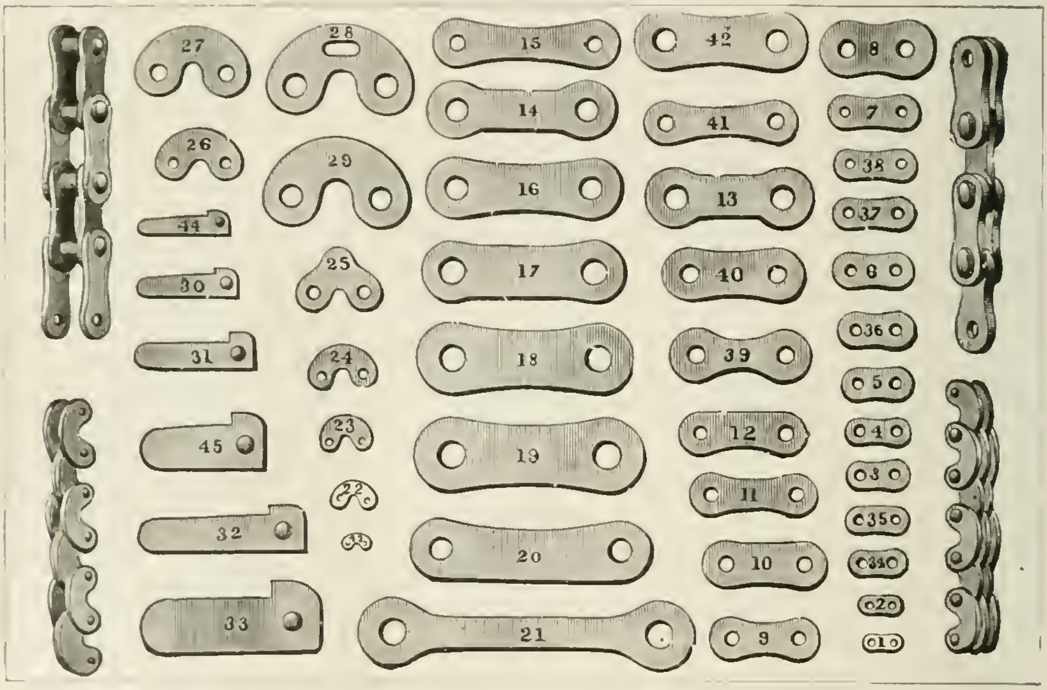


Fig. 1.

Diameter of Link.	Weight per foot.	Breaking Strain.	Diameter of Link.	Weight per foot.	Breaking Strain.
Inches.	Pounds.	Pounds.	Inches.	Pounds.	Pounds.
3/16	.35	1,731	1	9.3	49,280
1/4	.63	3,069	1⅛	11.8	59,226
5/16	.91	4,794	1¼	14 5	73,114
3/8	1.33	6,922	1⅜	17.7	88,301
7/16	1.80	9,408	1½	20.8	105,280
1/2	2.33	12,320	1⅝	24.2	123,514
9/16	3.00	15,590	1¾	28.3	143,293
5/8	3.67	19,219	1⅞	32.5	164,505
11/16	4 50	23,274	2	38 3	187,152
3/4	5.30	27,687	2¼	47.0	224,448
13/16	6.16	32,301	2½	58 0	277,088
7/8	7.16	37,632	2¾	70.0	335,328
15/16	8 16	43,277	3	84.0	398,944

Chains with flat links are made in the fly-press. The links are cut out, and the holes are afterward punched as in washers, one at a time, every blank being so held that its circular extremity touches the stops on the bed or die, which insure the centrality of the blank and punch. The two holes are thus made equidistant in all the links, and are afterwards strung together by inserting keys or rivets through the holes. Sometimes the succession of the links of the chain is one and two links alternately; or three and two; or four and three, up to eight and nine links, which is sometimes used. Chains intended to catch on pins or projections on the periphery of a wheel are made two and two, leaving an opening which slips over the cog. A full assortment of punched chain-links and keys is shown in Fig. 1. These links are made with special machinery by Messrs. Hoopes & Townsend, Philadelphia, and have been tested for ordnance purposes with the following results:

STRAIGHT CHAIN-LINKS.

No. in Fig. 1.	Breaking Strain as tested.	Entire Length	Length from center to center.	Thickness.	Diameter of Holes.	Weight per 100 Links.
	lbs.					
1....	615	7/8 inch	1/2 inch	No. 16	5/32 inch	.32
2....	750	15/16 "	1/2 "	" 14	3/16 "	.50
34....	900	1 3/16 "	5/8 "	" 12	7/32 "	1.40
35....	1,000	1 3/8 "	3/4 "	" 11	1/4 "	1.87
3....	1,000	1 3/8 "	3/4 "	" 11	1/4 "	2.00
4....	1,450	1 7/16 "	7/8 "	" 10	1/4 "	2.15
5....	1,100	1 9/16 "	7/8 "	" 10	9/32 "	2.80
36 ...	1,500	1 5/8 "	7/8 "	" 8	5/16 "	4.75
6....	1,600	1 3/4 "	1 "	" 10	5/16 "	3.75
37....	1,575	1 11/16 "	1 3/32 "	" 10	9/32 "	2.75
38....	1,225	1 3/4 "	1 1/8 "	" 11	1/4 "	2.66
7....	2,200	2 "	1 1/4 "	" 10	9/32 "	4.37
8....	4,400	2 1/2 "	1 1/4 "	3/16 inch	7/16 "	15.62
9....	4,450	2 3/8 "	1 1/2 "	No. 7	5/16 "	8.00
10....	3,500	2 3/4 "	1 3/4 "	3/16 inch	3/8 "	12.25
11....	4,200	2 3/4 "	1 15/16 "	1/4 "	5/16 "	11.43
12....	4,200	2 3/4 "	1 15/16 "	1/4 "	5/16 "	12.75
39....	7,200	3 1/8 "	2 "	5/16 "	15/32 "	18.50
40....	7,800	3 1/8 "	2 "	3/8 "	15/32 "	26.00
13....	7,900	3 9/16 "	2 5/16 "	7/16 "	1/2 "	41.00
41....	3,900	3 7/16 "	2 1/2 "	3/16 "	3/8 "	12.00
42....	5,900	3 3/4 "	2 1/2 "	1/4 "	1/2 "	24.00
15....	5,000	4 "	3 "	1/4 "	3/8 "	16.00
14....	11,800	4 1/16 "	2 7/8 "	3/8 "	1/2 "	36.00
16....	9,200	4 3/8 "	3 "	5/16 "	1/2 "	36.62
17....	9,000	4 1/2 "	3 3/16 "	7/16 "	5/8 "	56.00
18....	11,500	4 3/4 "	3 1/4 "	3/8 "	9/16 "	45.00
19....	12,500	5 1/8 "	3 1/2 "	7/16 "	21/32 "	80.00
20....	12,000	5 3/8 "	4 "	7/16 "	17/32 "	74.62
21....	11,000	7 3/4 "	5 31/32 "	3/8 "	19/32 "	70.50

COG-LINKS.

43....	350	5/8 inch	3/8 inch	No. 14	3/32 inch	.25
22....	650	1 "	5/8 "	" 12	5/32 "	.94
23....	775	1 3/16 "	21/32 "	" 12	3/16 "	1.75
24....	925	1 7/16 "	15/16 "	" 11	7/32 "	3.20
25....	1,275	1 7/8 "	1 1/8 "	" 10	5/16 "	6.43
26....	1,275	1 7/8 "	1 1/8 "	" 10	5/16 "	5.20
27....	1,975	2 1/2 "	1 1/2 "	3/16 inch	3/8 "	11.43
28....	2,200	3 1/4 "	2 "	3/16 "	1/2 "	18.75
29....	2,200	3 1/4 "	2 "	3/16 "	1/2 "	20.37

Nos. 30, 31, 32, 33, 44, and 45 are keys for 1/2, 5/8, 3/4, 1 1/4, 1 3/8, and 1 inch bolts respectively.

The *roller detachable chain-belting*, made by the Lechner Manufacturing Company, is now generally used throughout the United States for driving elevators, drags, heavy and light shafting, conveyors, hoists, log-haul-ups, traction-engines, racking-carriages on lifting-cranes, roller-trains in rolling-mills, live rolls, etc. Fig. 2 shows a roller detachable chain-link one half actual size, with a working strain of 3500 pounds. The method of detaching the links, shown in Fig. 3, is very simple, and is as follows: Bring the links to right angles with each other, by a slight tap on the roller; change the position of the pin from the narrow to the larger portion of the slot, when it (the pin) can be driven through and out, and the chain detached. This belting has many superior qualities. 1st. The action of the roller upon the sprocket-wheels and links greatly reduces friction and the usual wear upon both, by rolling when coming in contact with the sprockets until seated, when it rests quietly till released by leaving the wheel, causing no scrape whatever. Again, when the chain is used for conveyors, in its movement on a plane or incline, it rolls upon the rollers, and thus requires much less power to drive the conveyor, than is the case where chains are dragged upon their flat surface. It also admits of a lighter chain to do the same

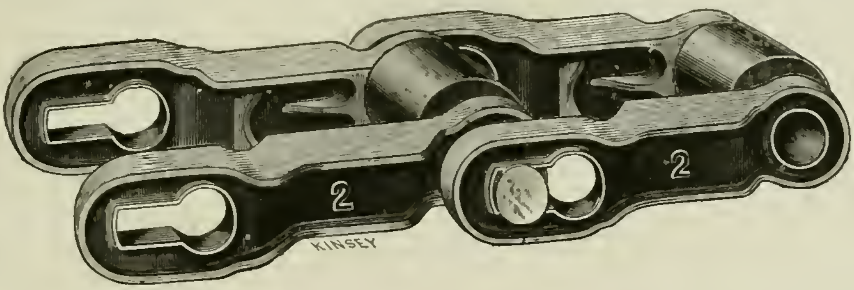


FIG. 2.

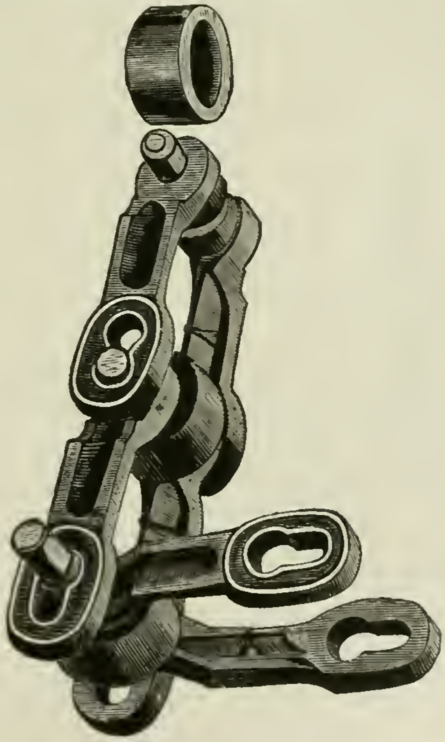


FIG. 3.

work, its strength not being exhausted in dragging its own weight. 2d. The formation of the links is such that the greatest strength to weight of metal is obtained, there being absolutely no weak point. 3d. By an examination of the links and pin after detaching, it will be discovered that the wearing surface, or bearing, covers the entire portion of the pin between the end grooves or notches, there being no wear upon the ends of pin or outside links, for the reason that the pin is held rigidly, not moving in the square slot. The pins and links are also greatly strengthened by the tubular bearing, or that portion of the link upon which the roller is mounted, and which, taken together, makes the strain upon the pin a shearing strain upon the ends, thus giving it greater strength than it would otherwise have. 4th. Fully ten per cent of power is lost by the slipping of leather and rubber belts, and the friction resulting therefrom rapidly generates heat, which hardens the face of the one and rots the fabric of the other, and is one of the most prevalent causes of fire in mills, warehouses, etc. 5th. When space is of importance, roller-chain of from 2 to 4 inches in width will be the equivalent of a 12 to 30 inch leather or rubber belt, and the sprocket-wheels for the chain will cost from one fourth to one half less than pulleys for leather or rubber belting.

CHAIN-BALL.—To arrest the motion of rotation of an oblong projectile thrown under high angles and with a moderate velocity, it has been proposed to attach a light body to its posterior portion by means of a cord or chain, which will offer a resistance to the flight of the projectile and cause it to move with its point foremost. See *Chain-shot.*

CHAIN-MAIL.—A kind of armor much used in the twelfth and thirteenth centuries. It was formed of hammered iron links connected one to another into a dress or form of a garment. Its advantage was in its lightness and flexibility, compared with the sheets of steel or brass of other metal armor, but it was not so good a protection from the spear or lance. Frequently spoken of as *chain-armor.*

CHAIN-SHOT.—A nearly obsolete kind of ammunition, chiefly used in naval warfare, consisting of two balls connected by a short chain. The object of the chain is to destroy the rigging, etc., which otherwise might escape. As grape-shot has been found to serve the same end, the making of chain-shot has been discontinued. See *Bar-shot, Projectiles,* and *Solid Shot.*

CHALK.—A white calcareous substance, prepared by precipitating a solution of chloride of calcium with carbonate of soda and washing; the precipitated chalk of the pharmacopœia is thus formed. Chalk is well known in Europe as an extensive secondary formation. In the arts it is commonly known as *whiting*, after separating the grosser impurities of the chalk. It is used very generally for artillery purposes in arsenal workshops, for marking the center and line of metal on ordnance, to mark the position of gun-carriages and mortar-beds on their platforms, and in a variety of uses.

CHALLENGE.—1. The act of a sentinel in questioning or demanding the countersign from those who appear at or near his post, at certain times. In the British service, the sentinel challenges in these words: "*Who comes there?*" At the same time he comes to the *charge bayonet* to prevent any sudden rush upon his post. If the reply of the approaching person is satisfactory, the sentry allows him to pass in these words: "*Pass, friend; all's well!*" A similar challenge is made to any patrol visiting the guards of a garrison or camp during the night, such as the Grand or Visiting Rounds.

In the United States army, after retreat (or the hour appointed by the Commanding Officer), until broad daylight, a sentinel challenges every person who approaches him, taking, at the same time, the position of *charge bayonet.* He suffers no person to come nearer than within reach of his bayonet, until the person has given the countersign, or is passed by an Officer or Non-commissioned Officer of the Guard. A sentinel, in challenging, calls out, "*Who comes there?*" If answered, "*Friend, with the countersign,*" and he be instructed to pass persons with the countersign, he replies, "*Advance, friend, with the countersign!*" If answered, "*Friends,*" he replies, "*Halt, friends! Advance one with the countersign!*" If answered, "*Relief,*" "*Patrol,*" or "*Grand Rounds,*" he replies, "*Halt! Advance, Sergeant* (or *Corporal*), *with the countersign!*" and satisfies himself that the party is what it represents itself to be. If he have no authority to pass persons with the countersign, if the wrong countersign be given, or if the persons have not the countersign, he causes them to stand, and calls, "*Corporal of the Guard!*" When any person approaches a post of the guard at night, the sentinel before the post, after challenging, causes him to halt until examined by a Non-commissioned Officer of the Guard. If it be the Officer of the Day, or any other Officer entitled to inspect the guard and to make the Rounds, the Non-commissioned Officer will call, "*Turn out the guard!*" when the guard is paraded, arms at a carry, and the Officer of the Guard, if he think necessary, may demand the countersign and parole.

2. The custom of calling another to answer for an offense by combat. In 1844 several new Articles of War were issued by the Commander of the Forces in England, with a view to the abatement of dueling in the army. They were as follows: 1. Every officer who shall send a challenge, or who shall accept a challenge, to fight a duel with another officer, or who, being privy to an intention to fight a duel, shall not take active measures to prevent such duel, or who shall upbraid another for refusing or not giving a challenge, or who shall reject or advise the rejection of a reasonable proposition made for the honorable adjustment of a difference, shall be liable, if convicted before a General Court-Martial, to be cashiered, or suffer such other punishment as the Court may award. 2. In the event of an officer being brought to a Court-Martial for having acted as a second in a duel, if it appear that such officer exerted himself strenuously to bring about an honorable adjustment of the difference, but failed through the unwillingness of the adverse parties, then such officer is to suffer such punishment as the Court shall award. 3. Approbation is expressed of the conduct of those who, having had the misfortune to give offense to or injure or insult others, shall frankly explain, apologize, or offer redress for the same, or who, having received offense, shall cordially accept frank explanations or apologies for the same; or, if such apologies are refused to be made or accepted, shall submit the matter to the Commanding Officer; and, lastly, all officers and soldiers are acquitted of disgrace or disadvantage who, being willing to make or accept such redress, refuse to accept challenges, as they will only have acted as is suitable to the character of honorable men, and have done their duty as good soldiers who subject themselves to discipline. Partly in consequence of these regulations, but still more as a result of the increasing reason and humanity of English society, the practice of dueling has become almost as entirely obsolete in the British army as it has in the country generally. The 26th, 27th, and 28th Articles of War prescribe the punishment for dueling in the United States army. See *Duel* and *Ordeal.*

3. In a legal sense, and as applied to military matters, the right the accused has of objecting to the President or any other Member of a Court-Martial. If he objects to the President, his objection, unless disallowed by two thirds at least of the other members, must be referred for decision to the authority by whom the President was appointed. When any Member is challenged, the accused must state his cause of challenge, of which the Court, after due deliberation, determines the relevancy or validity, and decides accordingly. See *Court-Martial.*

CHAMADE.—A signal made for a parley by beat of drum. See *Parley*.

CHAMBER.—1. A gun is said to be chambered when the seat of the charge is not of the same diameter as the bore. The object of chambering is to obtain increased projectile force. Formerly the chamber was in all cases smaller than the bore, the shape commonly cylindrical or conical. Chambers were placed in light pieces firing comparatively small charges of quick-burning powder. It was considered that the length of space occupied by the charge should be nearly equal to its diameter, in order that the inflammation of the charge should be nearly complete before the gas commenced to escape through the windage, or the projectile had sensibly moved from its place; in the second place, this form of cartridge gave less surface for the absorption of heat by the surrounding metal. It also gave to the cartridge in some cases a more manageable form in loading. In pieces firing heavy charges the seat of the charge was simply the bore prolonged. The termination was in some cases a plane bottom connected with the sides by a curved surface, and in others the bottom of the bore was hemispherical or semi-ellipsoidal. The latter was thought to be more favorable to the strength of the piece. It was necessary that there should be no angles formed by the junction of the bottom and sides of the bore, as these would become receptacles for the residne and burning fragments of the cartridge-bag. There is also a well-known tendency for rupture to commence at an angle, and for this reason, too, the curved termination was necessary.

Chambers are now of larger diameter than the bore proper, and are so made to enable the use of larger charges, aud also to give a certain amount of air-space about the cartridge. They were originally adopted as a necessity in breech-loading guns firing lead-coated projectiles. The tendency at present is to use very large charges of slow-burning powder. If, however, too great a length of cartridge is employed, experience shows that at times abnormal pressures are exerted upon the bore and projectile; the gas rushes from the point of ignition to the end of the powder-chamber and there, being suddenly arrested, produces a zone of high pressure within which the powder burns abnormally fast; then a back-rush takes place and a violent wave-action is set up, resulting in local strains of great severity without materially affecting the velocity of the shot. This difficulty is obviated by an increase in the diameter of the cartridge. The air-space about the cartridge also prevents the dynamic action of the gases described above. It diminishes the mean density of the inflamed products during the first instants of combustion and relieves the piece of the great strain usually brought upon it before the projectile has commenced to move. The maintenance of a due proportion between the bulk of the powder-charge and the space allowed for its combustion is of the highest importance both in the development of energy and the diminution of strain upon the gun. The velocity and energy are increased in less proportion than the increase of charge, but the gas-pressure is not increased in amount, although prolonged in duration, by the heavier charge, if the proportion of space to weight of powder remains the same. The proper dimensions of the chamber in relation to the caliber and length depend very much upon the nature of the powder employed. With some large-grained powders, especially the prismatic variety, it is thought that the charge can completely fill the chamber, the air-space in the interstices and perforations being sufficient to produce the desired effect. Beyond a certain limit the further boring out of the chamber would begin to weaken the breech. In many heavy guns the chamber has a diameter, for a considerable length, of one or two inches greater than the bore. The length should not be more than 3½ or 4 times its diameter if it can possibly be avoided.

The construction with reference to length of bore, etc., will be governed by the purposes for which the piece is intended. I. For armor-piercing the projectile required is a long pointed bolt, nearly solid. It must strike with great velocity, and therefore must be propelled by very large charges. Hence a gun for this purpose should have a large chamber and a comparatively small bore of great length. II. For breaching fortifications *curved* fire is necessary; the escarps of modern fortresses are usually covered from view by screens of earth or masonry, so that the projectiles must pass over the crest of the screen and drop sufficiently to strike the wall about half-way down—that is to say, at an angle of 15° or 20°. For a shell to drop at this angle at the end of a moderate range the velocity at starting must be low. Hence in pieces used for breaching no enlarged powder-chamber is wanted; the shell must be of a shape to hold the most powder for a given weight, and therefore rather short and thick. This gives a large and comparatively short bore. III. For producing destructive effect among troops Shrapnel is principally employed. For this high remaining velocities are required at the point of rupture. The gun must therefore take a large powder-charge. The interior capacity of the envelope should be as great as practicable. For a given weight a comparatively short projectile of large diameter will best fulfill this condition. Thus the proportions of the field-gun will be intermediate between those of the armor-piercing and the shell gun.

2. The chamber of a mine is a cavity formed to receive the charge of powder. When the chamber is made at the end of a gallery, the center of the chamber is placed on a level with the floor of the gallery. It is usually better to place the chamber at the end of a small branch return on one side. When the charge is not to be exploded immediately, or the ground is much saturated with moisture, it should be placed in a well-pitched wooden case, a good cask, or in a wooden case covered with tarpaulin, or any like expedient adopted that may be at hand; the best receptacle is a water-tight tin case. In dry ground, and when the charge is to be soon exploded, canvas bags will answer. If the case to contain the powder is cubical and not more than 2 feet on the edge, it may be introduced into the chamber ready made; if of greater dimensions, it must be put together in the chamber, the pieces to form the sides being arranged like the cases of branches. An opening is made in the cover near the side, about 4 inches square, for the introduction of the charge, and a similar one in the side near the center to receive the hose through.

CHAMBER-GAUGE.—An instrument used in the inspection of cannon. The head of this gauge should be made of close-grained, well-seasoned wood, and of the exact dimensions of the chamber. Two planes crossing each other at a right angle, coinciding with the vertical and horizontal central sections, have been found better than a solid block. The edge should be beveled. A socket in its center connects it with the measuring-staff. Being pushed to the bottom of the bore, if the length coincides with that obtained by the point it is obvious that the chamber is large enough, provided the cylindrical part has not been bored too deep, in which case a shoulder would be formed at the junction. The edges of the gauge should be chalked before insertion. When withdrawn, if the chalk-marks are visible all around the chamber it is evident the chamber is not too large. An examination of the *chamber-reamer* will be very satisfactory, and if found correct in size and shape the impossibility of making the chamber too large will be apparent. See *Inspection of Ordnance*.

CHAMBERS HOOPED GUN.—To obviate the danger of crystallizing the iron by welding it in large masses, this cannon is formed of pieces of a moderate thickness only, commencing with a tube the interior of which is the bore of the gun. The outside of this tube is turned to receive a series of rings, which have an interior diameter, such that they will not when cold pass on or over the tube, but when heated will readily slip on and come to the required position. When these rings are shrunk upon the barrel, the piece is placed in a lathe and the exteriors of the rings are turned so as to receive another tier of rings, which are placed by heating and shrinking on, so as to break joints with the first tier. When a greater number of courses of rings is necessary, they are placed on the preceding series in the same manner as the second series is placed upon the first; that is, so as to break joints with each other. The last series of rings is turned off to the regular form of the finished cannon. The trunnions are forged with one of the outside rings, which, for the purpose of strengthening the connection, may be made thicker than the other exterior rings. See *Ordnance*.

CHAMFER.—A small channel or furrow cut in wood, stone, etc. It may be also explained as an edge, or arris, taken off equally on the two sides which form it, leaving what is called a chamfer or a chamfered edge. If the arris be taken off more on one side than the other, it is said to be splayed or beveled.

CHAMFRON.—The frontlet of an armed horse, usually having a spike between the eyes. Also written *Chamfrain* and *Chamfront*.

CHAMPION.—In the judicial combats of the Middle Ages it was allowed to women, children, and aged persons, except in cases of high treason or of parricide, to appear in the lists by a representative. Such a hired combatant was called Champion. Those who followed this profession were generally of the lowest class, and were held disreputable; for besides the perils of the combat, they were liable to be executed as well as their clients. They were obliged to wear a peculiar dress of leather, and peculiar armor, which was also held disreputable. They were not allowed to fight on horseback, and appeared in the lists with their hair and nails cut short. Champions are mentioned as early as in the time of Charlemagne; and Otto I. employed them in deciding the succession to the Empire. At a later period, in the Age of Chivalry, the word Champion came to have a more dignified acceptation, and signified a knight who entered the lists on behalf of an injured lady, of a child, or of any one incapable of self-defense In England, the Crown even had its Champion, who, mounted on horseback and armed to the teeth, challenged, at every Coronation at Westminster, all who should deny the King to be the lawful Sovereign of the three realms. This practice is understood to have been first introduced under Richard II., and it continues to make a part of the Ceremonial of an English Coronation to this day. The name of Champion was also given to the knight who during a tournament had charge to see that no injury or insult should be offered to the assembled ladies.

CHANDELIER.—In military engineering, a wooden frame filled with fascines, to form a traverse in sapping.

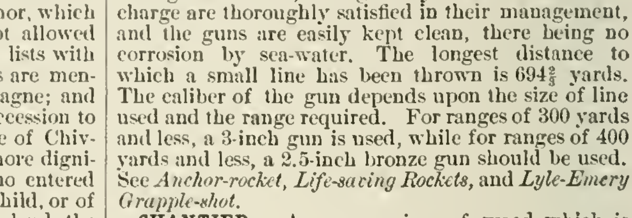
CHANDLER ANCHOR-SHOT.—This shot was originally intended for the use of ships on shore (aground), where the surf is too heavy for boats to land without the assistance of a line. It can also be used at Life-saving Stations to throw lines over beached vessels, or vessels in distress. As an implement of war, it will be useful in waters where torpedoes are supposed to be located. A ship can anchor near the supposed torpedoes, throw the shot two or three hundred yards towards them, and haul it home, breaking such wires as it may encounter. It is very simple, and its simplicity insures its successful working, while its cost is very little more than that of an ordinary shot. It is merely a shot with hinged anchor-flukes projecting from its sides and folding back into slots, so as not to interfere with the entrance of the shot into the gun. To the rear of the shot a chain or wire rope is attached, and carried to the front through another slot, in a very simple and substantial manner. In using it the shot is to be inserted into the muzzle of the gun far enough to bring the ends of the arms inside the muzzle, the chain or wire rope attached to the rear of the shot brought out through the slot, the strap taken off, and the shot pushed gently home. The springs under the arms, always bearing or pushing them outwards, will extend the arms as soon as the shot leaves the muzzle of the gun or mortar, and a perfect anchor will be projected. If in its flight the arms are brought in contact with anything, they will close until the obstacle is passed, and where the shot lands its holding power will be equal to any kedge-anchor of the same weight. It appears to be a most useful invention. One of these shots made for an eleven-inch gun would have power enough to carry a two-inch rope ashore; and after the shot was once ashore and well hooked, all the boats of the ship could be hauled ashore without any other line. The flukes of this anchor-shot are three in number, placed equidistantly around the circumference of the shot

In the U. S. Life-saving Service, no claims of very great originality are made, as the apparatus is a direct evolution from the system of Captain Manby, which dates back to the beginning of the present century. The advances which have been made during the past few years are the result of careful study and conscientious experiment. The data recorded are of value for future reference. Several hundred guns have been made, and every station supplied, at a great economy in the cost of manufacture; the guns being made at the West Point foundry, by contract. During the many heavy storms on our coast they have been used with great success, saving many lives. The men in charge are thoroughly satisfied in their management, and the guns are easily kept clean, there being no corrosion by sea-water. The longest distance to which a small line has been thrown is 694⅔ yards. The caliber of the gun depends upon the size of line used and the range required. For ranges of 300 yards and less, a 3-inch gun is used, while for ranges of 400 yards and less, a 2.5-inch bronze gun should be used. See *Anchor-rocket*, *Life-saving Rockets*, and *Lyle-Emery Grapple-shot*.

CHANTIER.—A square piece of wood which is used for the purpose of raising anything. It serves to place barrels of gunpowder in a proper manner, and frequently to try pieces of ordnance instead of frames.

CHAPE.—1. The catch or piece by which an object is attached—to a belt, for instance; as the piece of leather known specifically as the *frog*, to which a bayonet-scabbard is attached; or a piece used to fasten a buckle to a strap or other piece of leather. 2. The hook of a scabbard. 3. The metallic part put on the end of a scabbard to prevent the point of the sword or bayonet from piercing through it.

CHAPEAU BRAS.—A military hat which can be flattened and put under the arm. In the United States army the chapeau is worn by General Officers, Officers of the General Staff, and Staff Corps, except the Signal Corps. It is worn with the front peak turned slightly to the left, showing the gilt ornaments upon the right side. See *Helmet*.



Chapeau Bras.

CHAPEL-DE-FER.—An iron cap, furnished with a broad and slightly curved rim. It was the head-piece of soldiery in the reign of William Rufus and in subsequent reigns.

CHAPERON.—A hood or cap worn by Knights of the Garter. Such a hood was at one time in general use, but was lately appropriated to doctors and licentiates in colleges. A person who acts as a guide and protector to a lady at public places is called a chaperon, probably from this particular piece of dress having been used on such occasions. The name was also applied to devices which were placed on the heads of horses at pompous funerals.

CHAPLAIN.—A clergyman with a military commission, giving him the spiritual charge of soldiers. The title was originally applied to the ecclesiastic who accompanied an army and carried the relics of the patron saint. It has now come to signify a clergyman not having charge of a parish, but employed to officiate at Court, in the household of a nobleman, or in an army, garrison, ship, etc. Such officials began early to be appointed in the palace of the Byzantine emperors. The practice afterwards extended to the Western Empire, and to the Courts of petty princes, and even of knights, and continued to subsist after the Reformation. Forty-eight clergymen of the Church of England hold office as Chaplains of the Queen in England, four of whom are in attendance each month. Six clergymen of the Church of Scotland have a similar title in Scotland; but their only duty is to conduct prayer at the elections of Scottish representative peers. A statute of Henry VIII. limits the right of nominating private chaplains in England: thus, an archbishop may have eight, a duke six, a baron three; and chaplains so appointed have certain privileges, and may hold two benefices with cure of soul.

In England, an Army Chaplain is a clergyman whose services are retained especially by the government for the soldiery of the army. There have been such Chaplains for many generations, and the office was at one time regarded as a salable perquisite; but the system was reorganized and improved in 1796. In recent years, Roman Catholic and Presbyterian Chaplains have also been appointed, a practice which indicates the progress of toleration. The Chaplains belong, not to *regiments*, but to the Staff of the army, so as to be generally available. At home they are attached to the military stations; but in the field they are located at headquarters, at the hospitals, and with the divisions. The officers at the stations usually arrange for the men to attend divine service at the nearest parish church; but this still leaves the Chaplains many duties to fulfill. Where, as sometimes happens, there is no regular church or chapel near at hand, the Chaplain reads and preaches to as many men as can conveniently group themselves around him at one time, and thus serves many different congregations at different times of the Sunday. He visits the sick at the hospitals, and examines and encourages the regimental schools. Among the wooden huts at Aldershott Camp a church has been built, which is rendered available for Chaplains of different religious denominations in succession. When the system of Army Chaplains was remodeled in 1796, a *Chaplain General* was appointed; this office was abolished by the Duke of Wellington soon after the termination of the great war, but revived by Mr. Sidney Herbert in 1846. The Chaplain General, who receives £1000 per annum, has duties partaking somewhat of those of an archdeacon. He assists the War Office in selecting Chaplains, and in regulating the religious matters of the army, so far as Church of England matters are concerned. His office forms one of the eight departments under the new organization of the War Office. There are 78 Chaplains on the Staff, besides officiating clergymen (not belonging to the army) and chapel-clerks. The commissioned Chaplains receive from 10*s.* to 22*s.* 6*d.* per day, besides allowances; and there are always some on half-pay; while the officiating clergymen receive head-money for the troops attending their ministrations. The whole expenditure for Chaplains, and other charges connected with divine service, figures in the army estimates at near £50,000 annually.

In the United States army there are thirty Post and four Regimental Chaplains; and there is usually a Chaplain in every regiment of militia, though they are not always ordained clergymen. The authorized Post Chaplains are assigned to the several Military Geographical Departments by the Lieutenant General of the Army, in conformity with the spirit of the law governing their appointment. Division and Department Commanders from time to time assign or transfer to posts within their commands, for the best interests of the service, the several Chaplains ordered to report to them. On their action being made known to the Adjutant General of the Army, the Secretary of War designates the posts as Chaplain posts, in conformity with law. Chaplains enter in an appropriate book an accurate record of all marriages, baptismal, and funeral services performed by them, both for persons in the military service and for civilians, at or near the posts where they are stationed, with such particulars relative to each case as may become of importance. This book is one of the post records, and is subject to examination by inspecting officers. An appropriate set of quarters, equal to the allowance of a Captain, is set apart permanently for the Chaplain at posts where Chaplains are employed. He is not disturbed in them further than by a reduction of his allowance, and only then when the quarters of the garrison are insufficient. He is not entirely displaced from them, nor is he allowed to choose quarters elsewhere.

CHAPLAIN GENERAL.—As the name implies, the chief of the Military Chaplains in the British army. The appointment of such an officer was first made by the lake Duke of York when Commander-in-Chief. The recommendation of Chaplains to the several garrisons is made by him to the Minister of War.

CHAPLET.—A garland or head-band of leaves and flowers. In Heraldry, a chaplet is always composed of four roses, the other parts being leaves.

CHAPPE.—A barrel containing another barrel which holds gunpowder. It likewise means a composition of earth, horse-dung, and wad that covers the mouth of a cannon or mortar.

CHARCOAL.—Charcoal is the fiber that remains after wood has been charred, and, as an ingredient in gunpowder, is next in importance to saltpeter. When anything like uniformity in the quality of the gunpowder is required, great care has to be exercised in its preparation, for the chemical composition of charcoal—i.e., the percentage of carbon contained therein—will affect the quality of the gunpowder to a considerable degree; therefore extreme care has to be exercised in charring the wood, seeing that gunpowder contains no less than fifteen per cent of charcoal. Much depends upon the quality and condition of the wood employed, and it is found that if the sap be thoroughly dried up in the wood previous to use it greatly assists in securing a first-class charcoal; this end can be attained by desiccating newly-cut timber in a hot chamber for ten or twelve days, although it is questionable whether the charcoal thus obtained is as good as that produced from wood that has been kept for a number of years to season by natural means. Small wood, perfectly clean, free from all bark, and quite dry, are the essential requisites for making good charcoal. The kind of wood commonly used is that of the willow species—the common white Dutch willow, the poplar, and the alder are generally preferred; other woods are, however, frequently used, and for a first-class strong powder the black dogwood is said to be the best, but its great costliness prevents its being largely adopted. Burning the wood in retorts is the method usually employed for procuring a light and equal quality of charcoal for gunpowder; pit-burned charcoal is, however, preferred for fuse and pyrotechnic compositions, etc., on account of certain qualities it possesses rendering it peculiarly adapted for such purposes. The method of burning in retorts is as follows: Small wood of about ten years' growth is preferred for powder-making. Alder and willow of this age will be probably four or five inches in diameter, dog-wood about one. The wood must be straight, perfectly sound, and entirely free from bark, and must be felled in the spring. Great stress is laid on the cleanliness of the wood. Any traces of bark adhering to it are not to be tolerated. If the wood is cut in the spring when the sap is rising, the bark is

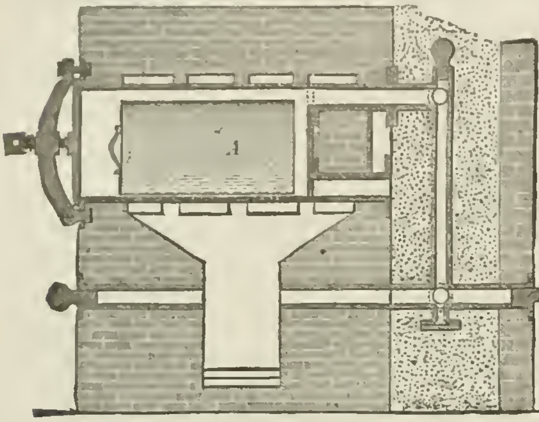


Fig. 1.—Charcoal Converter.

easily removed and the wood is left perfectly clean. Wood cut at any other season of the year is just as good, only in this case the removal of the bark is a much more difficult matter.

The wood is converted into charcoal in iron retorts or cylinders set into brick-work. Fig. 1 represents a longitudinal section of a cylinder, showing how the second cylinder, or slip, A, containing the wood, is placed in its interior, and the arrangement of pipes by which the gaseous matter evolved from the wood is conducted into the fire. Each cylinder is made of cast-iron, having two pipes passing out at the inner end of it. When set, the lower one of these is closed with brick-work, the upper one only being used, and the lower one being only intended for use should the cylinder be turned round and reset. To the uppermost pipe is attached a branch-pipe leading to a horizontal pipe extending behind the whole set of cylinders, from one end of which another pipe descends perpendicularly, joining another leading directly into the former. Each cylinder has a false bottom of brick-work, in front of which is bolted on a piece of wrought-iron plate having a cylinder-hole corresponding to the uppermost pipe of the cylinder. The cylinders are closed with tight fitting iron doors secured by a powerful screw, much in the same way as the ends of gas-retorts are fastened.

For convenience of handling the wood is placed in small cylinders of sheet-iron, A, termed *slips*, which are placed on small iron traveling-carriages, on which they can be run up directly to the mouth of the cylinders and shot in. The back end of each slip is provided with a handle to facilitate withdrawal. As already stated, a good and uniformly pure charcoal is very essential in manufacturing gunpowder, and if properly made will have a jet-black appearance, the fractures show a velvet-like surface, and appear the same in both large and small pieces. It should not scratch soft polished metal, and if treated with distilled water there should be no appearance of alkali. From 20 to 25 per cent of charcoal is obtained from the willow and alder, and from 25 to 30 per cent is yielded by the black dogwood; the latter is very dense, tough, and of slow growth, its usual size being about 1 inch in thickness. When charred it has a yellowish-looking surface, and is slightly metallic in appearance in certain shades of light. The kind of wood from which the charcoal has been made is known by the pith; that of dogwood is circular and large for the size of the wood; that of the willow is also circular, but somewhat smaller; whilst in the case of alder it forms a figure of three equidistant radial lines. They can all be easily distinguished from each other. Charcoal is very porous, and quickly absorbs moisture on being exposed to the atmosphere; therefore a great store is never kept, but is used as soon as possible after being made. Previous to this, however, it is very carefully examined and picked, as thick pieces which have not been properly charred are sometimes found. To test charcoal and ascertain if any alkali be present, finely powder a small quantity and boil it in distilled water; filter the solution, and test with litmus-paper reddened by weak acid. Should the charcoal contain alkali, the paper will be partially or wholly restored to its original color.

Charcoal after standing a fortnight is ground in an apparatus somewhat similar to a coffee-mill on a large scale. The mill consists of a cone secured on a vertical spindle provided with teeth running spirally over its entire outer surface; the cone revolves in a cylinder provided with teeth on its inner surface; these teeth are spiral also, but incline in the opposite direction to those on the cone. The revolving cone is adjustable in a vertical direction to increase or diminish the space between its teeth and those of the fixed cylinder; thus a coarse or fine charcoal is produced at will. The adjustment is effected by means of two hand-wheels working on a fine screw-thread cut upon the small vertical cone-spindle, which spindle can be moved upward or downward by means of the hand-wheels through the large hollow shaft upon which the bevel driving-wheel is keyed. Motion is communicated from this shaft to the small one by means of a feather upon the surface of the latter, which fits and works in a groove cut in the inside of the hollow shaft. The small hand-wheel is used for locking and securing the larger one in any required position. The hopper above receives the charcoal. On the under side of the cone, and revolving with it, are a couple of arms, that carry the ground charcoal to the discharge-spout on one side of the fixed cylinder and conduct it to a sifting-reel. This reel is simply a skeleton-cylinder of wood, covered with copper-wire cloth, having fine meshes thirty-two to the inch. The sifting-reel is driven by a pair of bevel-wheels set at a slight angle to allow the charcoal to run readily along the interior: as it revolves it causes the particles of charcoal to be continually rolling over each other and covering new surfaces of the reel; the fine particles pass through the meshes of the wire cloth and fall into a receiving-bin, whilst the larger ones are thrown out at the lower end of the reel to another bin, whence they are taken and returned to the hopper. The reel and bins are inclosed entirely in a wooden framework and covering, so as to prevent the dust, which is very light, from spreading over the house. Doors are provided in this wooden covering, by means of which the ground charcoal can be removed. After being ground the charcoal stands for about eight or ten days before using it; owing to the readiness with which it absorbs oxygen when in the pulverized state it is apt to become heated, and spontaneous combustion to ensue. The danger from this cause is much lessened when it is stored in small quantities

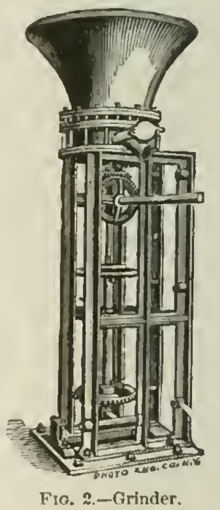


Fig. 2.—Grinder.

and in separate iron cylinders or bins. See *Gunpowder*, *Pit-burned Charcoal*, *Saltpeter*, and *Sulphur*.

CHARGE.—1. The position of a weapon fitted for attack; as, to bring a weapon to the charge.

2. In Heraldry, the figures represented on a shield are called charges, and a shield with figures upon it is said to be charged. The charges in a shield ought to be few in number, and strongly marked, both as regards their character and the mode of their representation. The family shield, belonging to the head of the house, almost always is simpler, i.e., has fewer charges, than the shields of collaterals, or even of junior members. See *Heraldry*.

3. In military pyrotechny, a sufficient combustible material for one firing or one discharge. It is applicable to all kinds of firings, fire-works, and explosions; but the name is generally given to the quantity of gunpowder requisite for firing off a gun, etc. In cannon this varies greatly, from $\frac{1}{4}$ to $\frac{1}{10}$ of the weight of the shot; some of the rifled ordnance now coming into use are remarkable for the smallness of the charge with which they are fired. The quota of charges will be mentioned in connection with the various kinds of fire-arms described in the Encyclopedia. In breaching a wall, a greater charge is necessary than in attacking a ship or a column of troops, even with the same kind of gun and projectile. The charge has to be duly proportioned to the strength of the piece and the capacity of the bore to burn it with profit. The strength of a heavy gun, as reckoned on the principle of all the metal being sound and so placed as to call its resistance well into play, should not be less than about four times the strain expected. If the projectile start as in a muzzle-loader, without offering much resistance beyond that due to inertia, it is necessary to employ a powder which shall burn quickly enough to give off a large proportion of its gas before the shot has proceeded far down the bore; otherwise the velocity at the muzzle will be low. In this case a large amount of air-space is required. In the case of compression-projectiles, however, there is a high resistance to initial motion, and a much slower powder can be used, since the combustion proceeds as in a closed vessel until sufficient pressure is developed to overcome the resistance of the band. This enables the use of a larger quantity of slower-burning powder in the chamber, and we have instead of a space filled with air a space filled with powder giving off gas, which comes into play as the projectile travels down the bore.

4. The statement of the crime for which an officer or soldier is brought before a Court-Martial. As to the perspicuity and precision of charges: If the description of the offense is sufficiently clear to inform the accused of the military offense for which he is to be tried, and to enable him to prepare his defence, it is sufficient. A copy of charges, as well as a list of witnesses for the prosecution, should be given to the prisoner in all cases as soon as possible. Antecedent to arraignment, charges may be framed and altered by the party who brings forward the prosecution, or by the officer ordering the Court, both in regard to substance and in other respects; but the Court, where the deviation was material, would probably deem it sufficient cause for delaying proceedings upon application of the prisoner. As the witnesses may be at a distance, the sooner a copy is given the better.

5. In military warfare, a charge is a sudden and impetuous attack on the enemy, by horse or foot, or both. Its object usually is to drive the enemy from a particular position; but if made with a much stronger force, it may result in his actual destruction. Charges are generally made silently. Those of Frederick the Great always began the "hurrah" at fifty paces from the enemy. If at the moment of the shock the infantry is not disturbed, but their bayonets and fire have on the contrary saved them from the impulsive force of the charge, the fall of the front ranks of the cavalry will have interposed a rampart behind which infantry cannot fail to be victorious. But if the cavalry has practiced the stratagem of beginning operations by drawing the fire of infantry upon skirmishers, and the Commander of the cavalry ready for the charge has pushed forward curtains of light cavalry in a single rank, who succeed, by means of clouds of dust, in making an unskillful infantry believe that to be an attack which in reality is only a feint, the infantry may fire its balls at random; the thinness of the curtain of light cavalry will render the infantry's fire of little effect; the infantry will be eager to reload, and this may be done in agitation and disorder. The proper moment is then at hand, and the heavy cavalry in mass, concealed by the dust of their skirmishers, may charge, break, and saber the infantry. The light cavalry finish the fugitives. The passage of defiles in retreat ought to be secured by a charge of cavalry. Coolness, silence, immobility, contempt of hurrahs, and a reserved fire until within suitable range, are the principal means of resisting a charge of cavalry. The file-closers must prevent firing, not ordered; watch the execution of the fire by ranks; see that it does not commence at too great a distance, then enjoin upon the soldiers to aim at the breast; to act only upon signals of the drum, or at the command of officers on horseback, who occupy the center of the square, and who from that height alone can judge whether the charge of cavalry is a mere feint or a real attack. This necessary impassibility of infantry is obtained by discipline and experience, and is only perfected upon battle-fields. Without *sang froid*, and also promptness in maneuvering upon any ground, infantry will not be able to exhibit the whole strength of its arm against the best cavalry. Charges by infantry are made in order of battle, in column of attack, and in close columns in mass. Charges in order of battle are executed as follows: If the combat is between infantry and infantry, the troops receiving the charge fire at the moment at which it is almost joined with the enemy. The troops making the charge fire at one hundred or one hundred and twenty paces from the enemy; without waiting to reload, they march forward at the quick step; at two thirds the distance take charging step, and if the ground permits they subsequently take a running step, keeping up the touch of the elbow, and throw themselves upon the enemy with hurrahs. Frederick the Great says that it is "better for a line to falter in a charge than to lose the touch of the elbow," so necessary is it that the charge should be *en muraille*. In modern wars the charge in column has been used, but not exclusively, and sometimes with fatal results. But whatever may be the form of the charge, success must not make the victor at once pursue his enemy. He must, on the contrary, halt, rally his men, form line if the charge was made in column, reload, fire upon the fugitives, and continue thus to gain ground, by a regulated fire, until at last the cavalry which seconds him comes to his aid. It must be considered that there may be a second line of the enemy, fresh troops, masked batteries, flank fires, or squadrons of cavalry ready to oppose an unforeseen resistance. It may be that the attacking party has experienced some disadvantage, not far from the point where the infantry has just triumphed in the charge. Such circumstances may cause the infantry to pay dearly for its temporary success, a temporary success sometimes owing to stratagem on the part of the enemy.

CHARGE BAYONET.—A command in the Manual of Arms, executed as follows: The Instructor commands—1. *Charge*, 2. BAYONET. Execute the first motion of *about face*, the left knee slightly bent, drop the piece into the left hand, at the lower band, the elbow against the body, the point of the bayonet at the height of the chin, the right hand grasping the small of the stock and supporting it firmly against the right hip, the body inclining slightly forward. 1. *Carry*, 2. ARMS. Resume the carry with the right hand, at the same time facing to the front.

(Two.) Drop the left hand by the side. See *Manual of Arms*, Fig. 7.

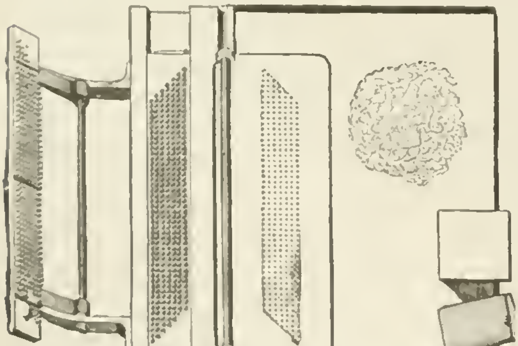
CHARGER.—1. A name sometimes given to a war-horse accustomed to the din of battles, and reliable under circumstances of confusion and danger. In the Middle Ages, when armor was used and gunpowder unknown, the military horses were *barbed* or *bardel* when ridden by men-at-arms—that is, they were nearly covered with armor. The face, the head, and the ears were covered with a mask called a *chanfron*, to prevent fright when charging the enemy; and an iron spike projected from the middle of the forehead. The neck was defended by small plates called *crinières*; the breast by a *poitrinal*; and the buttocks and haunches by *croupières*. These various pieces of armor were mostly made of metal, but sometimes of tough leather. The horse was occasionally covered with chain-mail; and in other instances with a *gambeson* of stuffed and quilted cloth. The man-at-arms generally rode another horse when not charging, to relieve the charger from his great burden. The barbed or *bardé* horse received its name from an old French word implying covered, clothed, or armed. A war-horse is still called a charger, though not armed as in ancient times.

2. A device for dropping into the bore of a fowling-piece from a shot-belt or pouch a gauged quantity of shot. By forcing down the plunger, the communication with the pouch is closed, and the charge is allowed to pass to the tube, which conducts it to the gun. The piston-head is adjustable, to vary the capacity of the charge-chamber.

CHARGER - PITS.—Shelter-pits to cover the charges of mounted officers when exposed to the enemy's fire. They may be excavated parallel to and 20 paces in rear of lines of shelter-trenches.

CHARGING-HOLE.—Formerly the French made their shells for sea-coast service with an additional eye, at an angle of 45 with the other, called a *charging-hole*, the object being to have the fuse already fitted in, ready for use, and allow the charge to be poured in just before the shell is wanted. This arrangement, however, has the disadvantage of requiring the fuses to be cut beforehand and without knowing at what distance they are to be used.

CHARGING-MACHINE.—A machine employed in the fabrication of cartridge-primers. The one used at Frankford Arsenal, and represented in the drawing, consists of a rectangular iron bed-plate 18 × 20 inches. At one edge is a groove to receive the plate of caps from the cooler. Near the inner edge of



this groove a plate perforated with holes corresponding to the caps is hinged to the bed-plate, to measure and convey the charges to the caps. A heap of the fulminate is placed upon the bed-plate, convenient to the charge-plate. A piece of stout paper is laid upon the bed-plate, under the charge-plate. A portion of the fulminate is taken from the heap, pressed into the holes in the charge-plate, and the surplus scraped off with a wooden tool and returned to the heap. The paper is drawn a little from under the charge-plate, while pressing upon the latter, to "set" the charges in the holes. The charge-plate is rotated on its hinge until it rests over the caps. A block of iron containing pins corresponding to the holes in the charge-plate is hinged to the bed-plate at the outer side of the groove containing the plate of caps. When not in use it rests against inclined supports. This block is next rotated on its hinge until it presses the charges through the holes in the charge-plate into the cap. The block and charge-plate are swung back and the plate of caps withdrawn and carried to the foiling-machine. The charge, of cylindrical form, occupies about one third the diameter in the center of the bottom of the cap, and it is desirable to avoid spreading or disturbing it, in order that the tinfoil disk may touch and adhere to the cap all around it. See *Cartridge-primer* and *Center-primed Metallic-case Cartridge*.

CHARIOT.—In ancient times, a kind of carriage used either for pleasure or in war. According to the Greeks, it was invented by Minerva; while Virgil ascribes the honor to Erichthonius, a mythical king of Athens, who is said to have appeared at the Panathenaic festival founded by him, in a car drawn by four horses. The ancient chariot had only two wheels, which revolved upon the axle, as in modern carriages. The pole was fixed at its lower extremity to the axle, and at the other end was attached to the yoke, either by a pin or by ropes. The Greeks and Romans seem never to have used more than one pole, but the Lydians had carriages with two or three. In general, the chariot was drawn by two horses. Such was the Roman *biga*, but we also read of a *triga*, or three-horse chariot, and a *quadriga*, or four-horse one. The last was that in which the Roman Generals rode during their triumphal entrance into the city, and was often adorned with splendid art. The war-chariot held two persons—the soldier himself and the driver, the latter of whom usually occupied the front; but the chariots used by the Romans in their public games held only the charioteer. The oldest war-chariots of which we read are those of Pharaoh (Exodus xiv. 7). All the Eastern Nations used them, while we learn from Cæsar that the Britons also were familiar with their use.

CHARLIER SYSTEM OF HORSESHOEING.—The reform in farriery caused by the revolution which followed the introduction of the Goodenough system has been fertile in new plans and expedients to avoid the clumsy old methods, and to evade the patents with which Mr. Goodenough protected his machine-made shoe in all the patent-granting world. In this country the Goodenough shoe is furnished at a lower price than the hand-made shoe, and it is infinitely superior to the common machine shoe, which is at best but a rough clump of bent iron, requiring as much labor upon the anvil to adapt it to the hoof as would be expended in making a well-shaped shoe from the iron bar. But in England and France, where labor is cheaper than it is in the United States, the evasion of the Goodenough patents has been eagerly sought. In France, Mr. Charlier, wishing to patent his own plans, which were very ingenious, and to adapt the Goodenough teaching to the smooth asphaltum pavements of Paris, invented the shoe bearing his name. Mr. Charlier recognizes the fact that the old system of heavy shoeing is irrational and destructive; that all the diseases of the hoof, and many of the other difficulties to which the horse is subject, come directly from it. He desires to abrogate entirely the use of the three-calked shoes and wide-webbed shoes, and to secure the full bearing of the frog of the hoof upon the ground. Mr. Charlier's method of shoeing is to dress the horse's foot, so that standing upon it he rests equally upon the shell and frog; then a groove is cut around the outer circle of the hoof, about as deep as the thickness of a light horseshoe, and an iron band is let into this groove and secured by nails. In effect, a light and very narrow shoe is sunk into the crust of the hoof. All shock of concussion comes upon the frog and the outer wall of the hoof, though with a full frog bearing such concussion would be light and immaterial. This, then, appears to be a natural and simple method of saving the hoof from breaking at the edge and from wearing too low at the toe, which is the only object of horseshoeing. But in practice we come upon difficulties that often destroy the best spun theories. The idea of Mr. Charlier is to provide an iron rim, or ferrule, to the hoof such as saves the point of a walking-stick from wear. But the shoe cannot have the strength of a ferrule because it is not put on to *encircle* the hoof, but only reaches to the heels. It is not applied to a dead or inert substance, but to a living, growing process, and, however well fitted to its groove, in a few days it has of necessity changed its place. So soon as the least displacement exists it is liable to twist and spread. Another serious difficulty is found in the lack of skill among horseshoers to apply it properly. In France two men are required, one to hold the foot, another to gauge, and then, with special tools, to cut the groove for the shoe. When a shoe is lost, or displaced on the road, a serious embarrassment is felt, because the groove-cut hoof is unsuitable to travel on, and only the instructed smith is competent to do the work of fitting. The expense, in this country of dear labor, is no insignificant argument against the Charlier shoe. See *Horseshoeing*.

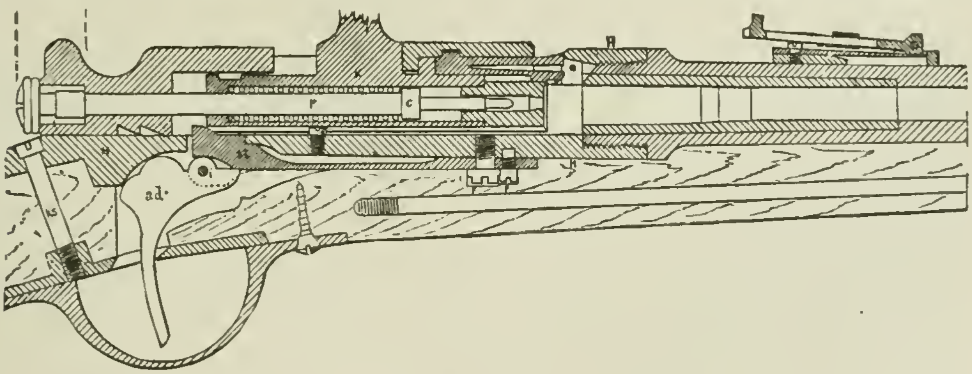
CHASE.—In gunnery, the conical part of the gun in front of the reinforce. In a smooth-bore gun it is comprised between the front of the second reinforce-ring and the muzzle astragal and fillets; or, perhaps, to put it in more comprehensive terms, the greater portion of the gun between the muzzle and the trunnion. The term is applicable to rifled guns as well.

CHASE-RING.—In gunnery, a band at the front end of the chase. See *Cannon*.

CHASING.—The art of working raised or half-raised figures in gold, silver, bronze, or other metal. It was called *cælatura* by the Romans; and the term is expressly limited by Quintilian to working in metal. The same art when exercised on wood, ivory, marble, precious stones, or glass was called *sculptura*. Iron was sometimes though rarely used, silver having been always the favorite metal for this purpose. Closely connected with, but still distinguished from, chasing is the art of stamping with the punch, which the Romans designated by *excudere*. The Greek *toreutike* is usually supposed to correspond to chasing, but the point is by no means free from dispute. The art was known at a very early period, as may be inferred from the shield of Achilles, the ark of Cypselus, and other productions of the kind.

CHASSELOUP BASTION SYSTEM.—This method of fortification is a combination of Bousmard's and Montalembert's systems. It gives 580 yards to the front, and takes a perpendicular of $\frac{1}{4}$. The faces of the bastions are bent lines; the salient part, 70 yards long, is traced on the front line, and the long branch is 160 yards in extent. The flanks are perpendicular to the line of defense, and defend the long branches, whilst the short ones, already secure against ricochet by their direction, are flanked by a caponiere, which occupies the place of the early ravelin. The flanks are parallel to the perpendicular. The main ditch is 20 yards wide at the salient, and its counter-scarp is directed on the shoulder-angle of the caponiere. The tenaille is similar to that of Bousmard, and the casemates are constructed for three guns. The reduits are casemated polygonal redoubts. Although the revetments are quite high, both the ravelin and the reduit are liable to be taken by the gorge.

CHASSEPOT RIFLE.—The Chassepot rifle was introduced into the French service shortly after the Austro-Prussian War of 1866. In its principal features it resembled the Prussian needle-gun, inasmuch as the breech was closed with a sliding bolt, and it fired a self-primed paper-case cartridge which was ignited by a needle impelled by a spiral spring. Unlike the needle-gun, however, it was provided with a gas-check, which was of the form of a thick India-rubber disk or packing, attached to the end of the breech-bolt, and it possessed the modern improvements of reduced caliber and rapid twist of the rifle-grooves for obtaining great range and accuracy of fire. The range of the Chassepot rifle was, and is now, comparatively greater than the accuracy of the flight of its projectile, a fact that undoubtedly arises from the great weight of the powder-charge in proportion to that of the projectile and a want of proper adjustment of the twist, etc., of the rifling to the velocity of flight. In the French service a low trajectory has ever been considered of greater importance than accuracy of flight, especially in line-firing. The Chassepot was the principal arm used by the French army during the German War. Since that time efforts have been made to adapt it to fire the modern metallic-case cartridge. The plan of alteration to this end adopted by the French authorities is that submitted by Captain Gras of the French Artillery Committee. In consequence of the great opposition offered to the altered arms by officers of the army who have had them in their commands, it is understood but little progress was at first made in the manufacture of new rifles or altering the old Chassepot rifles to the Gras system. The Gras system of alteration consists, 1st, in reaming out the old paper-cartridge chamber and inserting in its place a bushing of steel in which a chamber is formed of suitable shape for the metallic cartridge; 2d, replacing the India-rubber gas-check and its attachments by a nose-piece, to which a cartridge-shell extractor-hook is attached; 3d, replacing the firing-needle with a stout firing-pin or bolt; 4th, removing the friction-roller in the base of the thumb-piece and replacing it with the firing-pin nut; 5th, changing



Chassepot Rifle.

the form of the locking-notches and the side groove of the body of the breech-bolt.

The breech-frame or receiver, H, is secured at its front end by screwing on to the barrel, and at the rear end by the tang-screw *ks*, which penetrates through the guard plate on the under side of the stock. The breech-bolt, K, is composed of a body in the form of a stout tube, with a handle attached to one side, for the purpose of working it. The hollow of the body contains the firing-pin and its spiral spring, and has a nose-piece to which the cartridge-shell extractor is attached. A slot is cut in the upper surface of the receiver through its entire length. The handle works in the rear portion of this slot, while the forward portion is enlarged by cutting down the right wall of the receiver to furnish a shoulder for the base of the handle to rest against when the bolt is locked and the piece is ready for firing. On the side and bottom of the body of the breech-bolt are two long grooves of rectangular cross-section. The object of the spiral direction of the side groove at its rear end is to force the handle into the cut of the receiver before the face of the nose-piece presses against the cartridge-head, and thereby prevent the bolt from flying backward in case of a premature explosion of the cartridge. The groove on the under side of the body is for the nose of the sear to play in without pressing on and impeding the motion of the bolt. The firing-pin, *p*, is made of steel. The body of the pin, which is enveloped by the spiral mainspring shown by the rows of small circles above and below it, is circular in cross-section. The collar, *c*, offers a shoulder for the mainspring to press against. The portion of the pin immediately in front of the collar is oval in cross-section, corresponding to the hole in the nose-piece, through which this portion of the pin passes. This form of the pin prevents it from turning in the nose-piece when the bolt is locked and unlocked, and regulates the motion of the thumb-piece relatively to the breech-bolt. The nose-piece is attached to the front end of the breech-bolt by means of a projection. A cylindrical projection on the nose-piece also fits into a corresponding recess in the forward end of the bolt. A continuation of the groove on the side of the bolt receives the point of a screw which serves as a stop to the bolt when pulled backward, and also to prevent the nose-piece from turning in the receiver when the bolt is locked. The under side of the nose-piece has a continuation of the groove in the bolt for the nose of the sear. A cut extends through the upper portion of the nose-piece to receive and hold the extractor-hook, which is composed of two branches, the lower one of which has a hook which takes hold of the rim of the cartridge. Its body has a certain elasticity which allows it to pass over the rim of the cartridge, while its hold on the rim is secured by the inclined surface of the cut *e* made in the receiver, into which the extractor fits. It also serves to keep the extractor in place in the nose-piece. The nut which secures the thumb-piece to the firing-pin has a milled head and a T-shaped groove in it, which fits on to the head of the firing-pin. The pressure of the mainspring on the pin prevents the nut from coming off by keeping it in its recess in the thumb-piece. The nose of the thumb-piece fits into a corresponding notch of the rear end of the body of the breech-bolt when the firing-pin is pushed forward against the cartridge-head and the bolt is locked. There is also a slight notch in which the nose rests to give the handle steadiness when in the vertical position. When the firing-pin is drawn back to the full-cock position the lower corner of the thumb-piece rests against the nose of the sear. At half-cock the nose of the sear rests in a notch, holding the point of the firing-pin at a safe distance from the priming of the cartridge. Another notch receives the nose of the sear when the point of the firing-pin impinges on the head of the cartridge. The upper portion of the thumb-piece is cut away and its surface checked to give a good hold to the thumb and fingers in manipulation. The sear, *st*, is attached to the under side of the receiver by two small screws. The smaller screw acts as a keeper to the larger. The body of the sear is a flat spring, so set as to cause the sear to protrude through a cut in the receiver and engage the notches of the thumb-piece. The trigger, *ad*, is a lever of the first order, and is attached to the sear by a joint-pin, *i*. Pressure on the finger-piece of the trigger depresses the nose of the sear, the rounded part of the trigger acting as a fulcrum against the under side of the receiver. The cartridge-case adopted for the altered Chassepot rifle is drawn out of sheet-brass in the usual way; the head is strengthened after the Hotchkiss plan, and it has the outside primer of Berdan. The bullet is solid and without cannelures, and weighs 386 grains; the powder-charge is 81 grains, and there is a lubricating-wad of the usual form between the powder and the projectile. The length of the bore, including the chamber, is 32.28 inches; the length of the complete arm, without saber-bayonet, is 50.8 inches, and with the bayonet it is about 72.0 inches. The weight with the bayonet is 10.3 pounds; without the bayonet, 8.9 pounds. The grooves are four in number, and of a width equal to that of the lands; the depth of the grooves is 0.0118 inch; the twist is one turn in 21.6 inches, and is from right to left instead of from left to right, according to the usual practice. The pull on the trigger is thought to disturb the aim by carrying the muzzle of the arm slightly to the right; the object of grooving the barrel to the left is to correct this disturbance by the drift which follows the direction of the twist. The initial velocity is stated to be 420 meters (about 1377 feet), and the effective range extends to 1700 yards, about one mile. The rapidity of fire is 15 times per minute. See *Mauser Rifle* and *Small-arms*.

CHASSEURS.—A name used for two important forces in the French army. The mounted Chasseurs (*Chasseurs-à-cheval*) are a body of light cavalry, designed for service in advance or on the flanks of the army, and correspond most nearly to the Light Horse of the British service. The name is first used in this sense in 1741, and has been retained while the force it denotes has undergone many alterations in organization and equipment. In 1831 a body of cavalry was raised for service in Africa, mounted on Arab horses, and with a distinct uniform. These have since become famous as the *Chasseurs d'Afrique*. After the reorganization of the French army in 1873 the effective army contained 14 regiments (subsequently increased to 20) of Chasseurs-à-cheval, besides 4 regiments of Chasseurs d'Afrique.—The infantry Chasseurs (*Chasseurs-à-pied*) are a light-infantry force in many respects corresponding with the cavalry Chasseurs, and like them intended for detached service (like the Rifle Corps in the English army). The French are believed to have adopted the idea of such a force of Sharp-shooters from the *Jäger* (the German word corresponding to Chasseurs, or *hunters*) in the German armies. First used in the Thirty Years' War, the Jäger derived their name from the fact that they were chiefly drafted from amongst mountaineers and inhabitants of forest regions. They have always been regarded as a valuable contingent in the Prussian and Austrian armies, or even constitute the entire force of light infantry. In the German army there are 26 battalions (near 15,000 men) of this force; in the Austrian service, upwards of 20,000 officers and men. In France the equipment of the Chasseurs differed little from that of the other infantry; it was not until the formation, in 1838, of the *Chasseurs de Vincennes* that the experiment of a specially armed force of Sharp-shooters was fairly tried. The fame of the Chasseurs de Vincennes for rapidity and precision of movement, as well as for the accuracy of their fire, soon vindicated the importance of this branch of the infantry; and at present there are 30 battalions of Chasseurs-à-pied in the French army.

CHASSEURS D'AFRIQUE.—The four regiments of cavalry, mounted on Arab horses, and raised for the purpose of warfare in Algeria. They took part, however, in the Franco-Prussian War of 1870–71, and also in the Crimea, where one of the regiments, the "Fourth," distinguished itself by supporting the charge of the light cavalry at Balaklava.

CHASSIS.—The chassis is the movable railway on which the top-carriage moves to and from battery. It is composed of two wrought-iron rails inclined three degrees to the horizon, and united by transoms, as in the top-carriage. In addition to the transoms, there are several diagonal braces, to give stiffness to the chassis. For the 10-inch gun and all smaller carriages the chassis-rails are single beams of rolled iron, 15 inches deep; for all calibers above, the rails are *built up* of long rectangular pieces of boiler-plate and T-iron, in a manner similar to that of the cheeks of the top-carriage. The chassis is supported by *traverse-wheels*, which allow of its having a horizontal motion, for the purpose of giving the piece a proper direction when aiming. The traverse-wheels roll on circular bars of iron resting on a bed of masonry or wood. The *pintle* is an upright journal, around which the chassis traverses. It is a stout cylinder of wrought-iron, inserted in and firmly fastened to a block of stone called the *pintle-block*. The *center-pintle carriage* is one in which the chassis is attached to the pintle at its middle, and revolves around it through the entire circumference of the circle. The traverse-circles are consequently continuous. By this arrangement a much greater horizontal field of fire is secured. The *front-pintle carriage* is one in which the chassis is attached to the pintle by its front transom; the traverse-circles are segments of circles. The *pintle-key* is a stout key of iron passing through the pintle, to prevent the chassis from jumping off when the piece is discharged. The pintle is surrounded by a plate firmly bolted to the block; this plate is called the *pintle-plate*, or *friction-plate*. The hurters and *counter-hurters* are flat pieces of iron bolted, the first to the front and the latter to the rear part of the chassis rails, to check the motion of the top-carriage when the piece is run *in battery*, and when it recoils upon being fired. In carriages of improved model the hurters and counter-hurters are stout buffers of gutta-percha, which, absorbing the shock, prevent racking of the carriage. The *guides* are stout claws of iron bolted to the cheeks of the top-carriage, and, catching under the flanges of the chassis-rails, prevent the carriage from slipping or jumping off. Through the chassis, immediately over the pintle, runs an eccentric axle, carrying upon each end a truck-wheel. This axle and wheels are for the purpose of throwing the chassis *in gear*, thus raising the pintle-transom from the friction-plate and allowing the carriage to be traversed with freedom. It is prescribed that the chassis shall be *out of gear* when the piece is fired. This, however, is not necessary, and the omission of it when firing saves much time and labor. The lighter class of carriages are without the arrangement just described. In the improved pattern of carriages the axle and truck-wheels above mentioned are replaced by two stout rollers attached to bolsters on the front end of the chassis. These rollers move upon the friction-plate, and give firm support and easy motion to the chassis. Casemate-carriages differ from barbette-carriages in being much lower, but their mode of construction is essentially the same. The pintle is placed immediately under the throat of the embrasure, and the chassis is connected to it by a bar of iron called the *tongue*. For the 10-inch smooth-bore and all below that caliber, recoil is checked simply by the inclination of the chassis-rails and the sliding friction thereon of the top-carriage. To increase this friction, the chassis-rails should be sanded with sand free from pebbles. See *Gun-carriages*.

CHAUCI.—An important tribe of ancient Germany, who dwelt between the Elbe and the Ems. Tacitus records that they were conspicuous for their love of peace and justice, being powerful but not ambitious, ready to resist aggression, but never provoking war They finally merged into the wider designation of Saxons.

CHAUFRON.—Masked armor which covered the face, the head, and the ears of military horses during the Middle Ages, to prevent the horses taking fright when charging the enemy.

CHAUSSES.—In the armor of the Middle Ages, defense-pieces for the legs. Some were made of padded and quilted cloth, with metal studs; some of chain-mail; some of riveted plates; and some of banded mail. It was not unusual to fasten them by lacing behind the leg. See *Armor*.

CHAUVINISME.—"Chauvin" was the name of the principal character in a French comedy which was played with immense success at the time of the Restoration. He represented a bragging veteran of the Empire, who was continually talking of his achievements at Austerlitz and Jena, and his determination to take a brilliant revenge for Waterloo. Since then a *Chauviniste* has come to mean a man who has extravagant and narrow-minded notions of patriotism, and corresponding enmity towards foreign peoples.

CHECK-HOOK.—A device in hoisting and lowering apparatus, designed to stop the motion of the wheel over which the rope runs if the machinery becomes unmanageable. On the pulley are hooks which fly out by the centrifugal force when the speed becomes excessive, and engage stop-pins which arrest the rotation of the pulley and the descent of the cage. 2. A hook on a saddle for the attachment of the bearing-rein.

CHECK-NUT.—A nut of frequent occurrence in the construction of artillery-carriages, the elevating-gears, etc. See *Lock-nut*.

CHECK-REIN.—The branch-rein which connects the driving-rein of one horse to the bit of the other. In double lines the left rein passes to the near-side bit-ring of the near horse, and a *check*-line proceeds from the said left rein to the near bit-ring of the *off* horse. The right driving-rein passes directly to the off bit-ring of the off horse, and has a *check-rein* which connects with the off bit-ring of the near horse. The horses of the Egyptian chariots had check-reins.

CHECK-ROPES.—Strong ropes employed to diminish recoil by increasing the frictional resistances. They are usually made fast to the lunette and felloes of the wheels just in rear of the working spokes. They prevent the wheels from turning in recoil, and thus increase the friction.

CHECKY.—In Heraldry, when the field or any charge is composed of small squares of different tinctures, generally metal and color, it is said to be checky. See *Heraldry*.

CHEEKS.—The sides of a gun-carriage in which the trunnions of the gun sit. The term "cheeks" is also applied in fortification to the interior facing of an embrasure. See *Embrasure* and *Gun-carriages*.

CHELONE.—In military antiquity, the form of battle adopted by the Greeks in besieging fortified towns. It served to protect the besiegers in their approach to the walls. This invention was formed by the soldiers placing their shields over their heads, in a sloping position, similar to the tiles of a house. The first rank stood erect, the second stooped a little, the third still more, and the last rank knelt. They were thus protected from the missile weapons of the foe, as they advanced or stood under the walls of an enemy. The chelone was similar to the *testudo* of the Romans.

CHELSEA HOSPITAL.—An edifice built on the banks of the Thames, which was originally begun by James I., and intended as a college for a certain number of learned divines. The unfinished buildings were afterwards completed, and finally converted by Charles II. into a hospital for non-commissioned officers and privates who were wounded or maimed in the service, and has remained to the present day a refuge for worn-out or wounded soldiers, who are termed "In-pensioners."

CHEMIN DES RONDES.—In fortification, a berm usually 4 to 12 feet broad at the foot of the exterior slope of the parapet. It is sometimes protected by a quickset hedge (in India a cactus hedge), but in more modern works by a low wall, built on the top of the revetment, through which (the wall being loop-holed) and over which the defenders can fire and throw hand-grenades into the ditch.

CHEMISE.—In mediæval fortification, an additional escarp or counter guard wall, covering the lower part of the escarp.

CHENAPPAN.—An old musket, invented in the latter part of the sixteenth century. The name *chenappan* was also given in France to robbers who used this new weapon, as also to the Spanish bandits of the Pyrenees who were enrolled under Louis XIII. The name was also applied to the Barbets of the Alps, the last remnants of the unhappy Vaudois, who were forced by religious intolerance to become marauders.

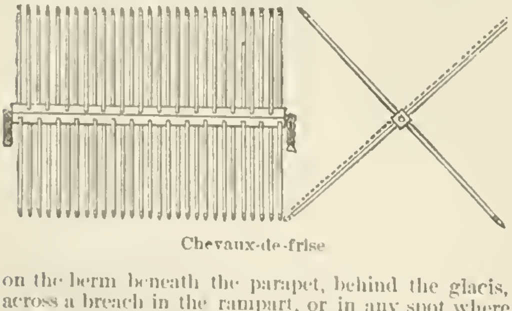
CHESSES.—The planking or flooring-boards of a ponton-bridge. In cylindrical pontons the boards are fastened to the baulks by means of cleats, but in the present-pattern pontons without cleats. Each chess consists of three planks. Half-chesses, consisting of a single plank, are used for that part of the floor which is immediately over the saddle of the ponton.

CHEST.—A technical name for the money and negotiable securities carried with an army, and intended to defray the current expenses. In the English military system this Department is managed by the Commissariat.

CHEVALET.—A sort of bell-tent formerly used in the French service when an army encamped. It resembled in some degrees the Indian wigwam.

CHEVALIER.—A horseman or knight. A member of certain orders of knighthood. In Heraldry, a horseman armed at all points.

CHEVAUX-DE-FRISE.—In fortification, a hastily-constructed substitute for a regular abatis, to stay the progress of an advancing enemy. It may be constructed in any way of wood or iron, provided it presents an array of sharp or ragged points towards the enemy. Sometimes it is made of barrels or centers of timber, with spears springing out from all sides, in such a way as to constitute both a support and a defense. Among the *matériel* of an army under the care of the Engineers are sometimes comprised chevaux-de-frise formed of cylindrical iron barrels, about 6 feet long, each having 12 holes to receive as many spears; the spears can be packed away in the barrel when not in use. Each such piece constitutes a *cheval;* and many such, ranged end to end, form *chevaux*, to be used in ditches around a fortification,



Chevaux-de-frise

on the berm beneath the parapet, behind the glacis, across a breach in the rampart, or in any spot where a check to the storming-party is needed. At Badajoz, during the Peninsular War, great service was rendered by a chevaux-de-frise formed of sword-blades fixed into beams of wood. The name is said to have been derived from "Friesland horse," and to have been first applied by the French during the wars of the seventeenth century. The drawing shows the common form of cheval-de-frise, consisting of a horizontal piece of scantling of a square or hexagonal form, termed the *body*, about 9 feet long, which is perforated by holes 2 inches in diameter and 5 inches apart; round staffs, 10 feet long and 2 inches in diameter, termed *lances*, shod with iron points, and inserted into the body, so as to project equally from it. At one end of the body a ring and chain are attached, at the other a hook and chain, for the purpose of attaching several together, forming a chevaux-de-frise. The square is the best form for the body; it requires only 5-inch scantling, whereas the hexagon will require 12 inch timber. See *Accessory Means of Defense.*

CHEVET.—A small wedge which is used in raising a mortar. It is placed between the frame and swell of the mortar.

CHEVRETTE.—An engine for raising guns or mortars into their carriages; also used in mechanical maneuvers.

CHEVRON.—1. In Heraldry, an ordinary representing the rafters of a house, and supposed to betoken the accomplishment of some memorable work, or the completion of some business of importance, generally the foundation of his own family by the bearer. The chevron is formed of two lines placed pyramidically, i.e., joined together at the top, and descending to the extremities of the shield in the form

Chevron. Chevronel. Per Chevron.

of a pair of compasses. *Chevronel*, a diminutive—half the size—of the chevron. *Per chevron*, or *party per chevron*, is where the shield is divided by a line in the form of the chevron.

2. The rank of non-commissioned officers is marked by chevrons upon both sleeves of the uniform coat and overcoat, above the elbow. The chevrons are of cloth of the same color as the facings of the uniform coat, and divided into bars a half-inch wide by black silk stitching, except for Engineers, which is white stitching and piped with white, points down; and Infantry, which is dark blue, according to patterns in the Quartermaster General's Office, as follows:

For a Sergeant Major, three bars and an arc; for a Quartermaster Sergeant, three bars and a tie of three bars; for a Principal Musician, three bars and a bugle; for an Ordnance Sergeant, three bars and a star; for a Commissary Sergeant, three bars and a crescent (points front) of same color as chevron and above it; for a Hospital Steward, a half-chevron of emerald-green cloth $1\frac{3}{4}$ inch wide, piped with yellow cloth, running obliquely downward from the outer to the inner seam of the sleeve, and at an angle of about thirty degrees with a horizontal, and in the center a "caduceus" two inches long, the head toward the outer seam of the sleeve; for a First Sergeant, three bars and a lozenge; for a Battalion or Company Quartermaster Sergeant, three bars and a tie of one bar; for a Sergeant, three bars; for a Corporal, two bars; for a Pioneer, two crossed hatchets, of cloth, same color and materials as the facings of the uniform coat, sewed on each sleeve, above the elbow, in the place indicated for a chevron (those of a Corporal being just above and resting on the chevron), the head of the hatchet upward, its edge outward, of the following dimensions, viz.: handle, $4\frac{1}{2}$ inches long, $\frac{1}{4}$ to $\frac{1}{3}$ of an inch wide; hatchet 2 inches long, 1 inch wide at the edge. For Enlisted Men of the Signal Corps, crossed signal-flags, red and white, on dark blue cloth; size of flags, $\frac{3}{4}$ of an inch square; length of staff, 34 inches. This device is worn by the Non-commissioned Officers above the chevrons; by Privates of the First Class on both arms, and by Privates of the Second Class on the left arm only, in the same position as the chevron of Non-commissioned Officers.

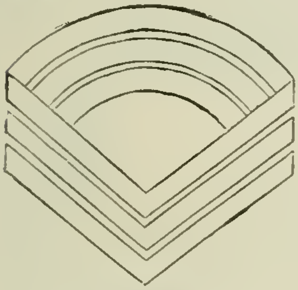
All Non-commissioned Officers, Musicians, and Privates who serve faithfully for one term of enlistment wear, as a mark of distinction, upon both sleeves of the uniform coat, below the elbow, a diagonal half-chevron, ½ inch wide, extending from seam to seam, the front end nearest the cuff and ½ inch above the point of the cuff, of the same color as the edging on the coat. In like manner an additional half-chevron, above and parallel to the first, is worn for every subsequent term of enlistment and faithful service. The distance between each chevron is ¼ of an inch.

The stripe indicative of War Service is white for all arms of the service or Corps. This stripe is known and designated as the "War Stripe," and is worn by enlisted men on the uniform coat as soon as the right to wear it has been earned. All soldiers who, during the War of the Rebellion, were in the Volunteer service are entitled to wear the War Stripe, provided they served in one or more campaigns in the field.

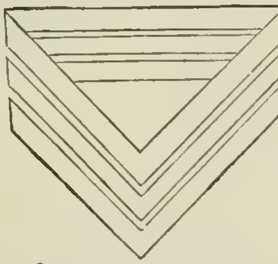
a separate portion. *On a chief* is when the object is represented on the chief divided off as above described. See *Heraldry*.

CHIEF OF DETACHMENT.—The senior non-commissioned officer of a gun-detachment. When in line, he is on the right of the front rank of his detachment. When, by facing about, the front becomes the rear rank, he does not change to the other flank, but steps forward into the rear (now become the front) rank. When in column of files, he is as if he had faced with his detachment from line.

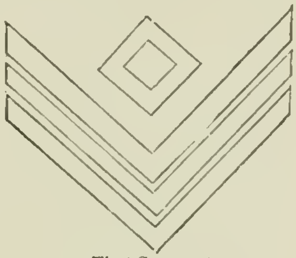
CHIEF OF ENGINEERS.—An officer of the army with the rank of Brigadier General, who has his headquarters at the seat of Government, and is charged, under the direction of the Secretary of War, with the command of the Engineer Department, including its Bureau, and with the regulation of the duties of the officers and troops of the Corps of Engi-



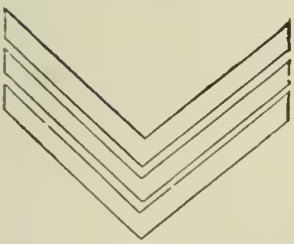
Sergeant Major.



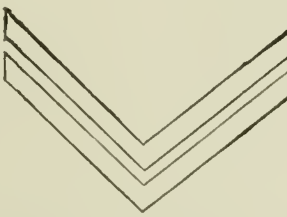
Quartermaster Sergeant.



First Sergeant.



Sergeant.



Corporal.

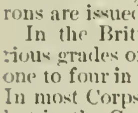
Ordnance Sergeant.

When, in addition to a War Stripe, an enlisted man is entitled to a Service Chevron, each edge of the latter is bound or faced by the former; and when, in addition to a War Stripe, an enlisted man is entitled to two or more Service Chevrons, they are separated by the War Stripe and the outer edge of each outside chevron is also bound or faced by the War Stripe. When worn in conjunction with the Service Chevron the War Stripe will be ¼ of an inch wide; when worn by itself its width will be the same as that of a Service Chevron, viz., ½ of an inch. War and Service Chevrons are issued without charge.

In the British service, the Corporals and the various grades of Sergeant have chevrons varying from one to four in number, either of white or of gold lace. In most Corps they are worn on the right arm only; but in the Guards, the Fusiliers, the Light Infantry, and the Grenadier and Light Infantry companies of the ordinary regiments, on both arms.

CHICANE.—To dispute every foot of ground by taking advantage of natural inequalities, etc.

CHIEF.—1. The head or leader of any band or community; a commander. 2. In Heraldry, an ordinary formed by a horizontal line, and occupying the upper part of the escutcheon. Like the other honorable ordinaries, the chief ought properly to take up a third part of the shield; but when the other charges are numerous, the chief is frequently diminished in size. Any object borne in the upper or chief part of the shield is said to be *in chief*, though the chief be not divided off from the rest of the field, as



Chief.

neers, as well as of all agents and others who may be employed under his direction within the limits of his Department. See *Corps of Engineers*.

CHIEF OF ORDNANCE.—An officer with the rank of Brigadier General who, under the Secretary of War, is, by law, charged with the administration and government of the Ordnance Department. By virtue of this authority he gives such orders and directions to its officers, soldiers, and employés as the necessities of the Ordnance service demand. He is also charged with the examination and settlement of the property accountability of all officers or other persons in the military establishment to whom Ordnance and Ordnance Stores are intrusted. The purchases and contracts for cannon, projectiles, powder, small-arms, and accouterments are made or specially ordered by the Chief of Ordnance, under the direction of the Secretary of War. See *Ordnance Corps*.

CHIEF OF THE STAFF.—An officer who ranks next to the General under whose orders he is serving, and is appointed to relieve the Commander-in-Chief of an army of an immense amount of detail work, and to harmonize the action of the several Departments. Such an officer is appointed in foreign armies. The question was raised, so far back as 1812, in England, whether a Chief of the Staff should be added to the Staff of the Commander-in-Chief. During the Crimean War, and subsequently in India during the Mutiny, an officer of this rank was appointed. In the United States, the Senior Staff Officer of a General is usually designated as the Chief of Staff.

CHIEF SIGNAL OFFICER.—An officer of the army, with the rank of Brigadier General, who is charged, under the direction of the Secretary of War, with the general Signal Service of the army; with the custody of all records and apparatus connected therewith; with the equipment and management of field-telegraphs used with active forces in the field; with constructing and operating lines of military telegraph; with maintaining signal stations at light-houses and at life-saving stations, and with the observations and reports required by law.

CHIEFTAIN.—A Captain, Leader, or Commander; a Chief; the head of a troop, army, or clan.

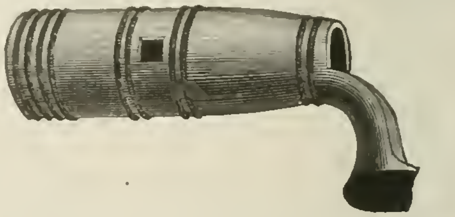
CHILIARCHIÆ.—The fourth of a Phalanx. The elementary tactical combinations of the Greeks were methodical, but very simple. An Army Corps was composed of a *Tetraphalangarchia*, or Grand Phalanx, an *Epitagma* of 8192 psiloi, and an Epitagma of cavalry of 4096 men. The Tetraphalangarchia = 4 Phalanxes = 16 *Chiliarchia* = 64 Syntagmata = 256 Tetrarchiæ = 1024 Lochoi or files = 4096 Enomitiæ of four men each.

CHILL.—A piece of iron introduced into a mold so as to rapidly cool the surface of molten metal which comes in contact therewith. Cast-iron, like steel, is hardened by rapid cooling, and softened by the prolongation of the cooling process. The extreme in the former direction gives *chilled iron* the hardness of hardened steel: the extreme in the direction of softness is obtained by prolonging the heat, abstracting the carbon from the cast-iron, reducing it to a nearly pure crystalline iron. See *Bronze Guns*.

CHILLED PROJECTILES.—Chilled-iron projectiles have been profitably employed to pierce armor-plates, on account of their intense hardness. The English projectiles recommended by Major Palliser may be described as an example of a chilled projectile. The form of these is cylindro-conoidal, the head being ogival, struck with a radius of 1½ diameters. The total length varies between 2 and 2½ calibers. The bottom is flat, and in the center of the bottom is a filling-hole for shells, closed with a composition screw-plug. All Palliser shells are lackered internally to give them a smooth, clean lining, which prevents the iron from either oxidizing at the expense of the powder, or firing it from friction by rapid rotation during flight. As the lacker does not always hold well to the metal, serge bags are introduced to contain the bursting-charge as an additional prevention against premature explosion. These bags are made bottle-shaped, and are introduced through the filling-hole. Palliser shot are cored. The hollow up the center enables them to cool more uniformly, and renders them less liable to split. It also slightly improves its proportions and its regularity of flight. The bottom is closed with a plug. These projectiles are made of carefully selected iron, which, if run in sand-molds, would solidify as mottled iron. The projectiles are cast point down, for the sake of density and soundness in the head. The mold is formed of a metal chill at the bottom extending up past the junction of head and body; the remainder of the mold is formed of sand, as also is the case for the formation of the interior. The chilling action therefore extends a little past the head of the projectile, which thus has a mottled body and a white head. The Grüson projectiles are cast with a dead-head on the base, which is afterwards cut off, the object being to obtain a solid bottom to stand well under the shock of the discharge. The chilling is effected by the metal molds, in virtue of their great conducting-power, their thickness greatly affecting the extent of their action. The head thus chilled white possesses generally the quality of white iron, intense hardness, crushing-strength, considerable brittleness, and increased density. The tip or point of a chilled projectile is occasionally broken off by the impact of a shell or shot rolled or struck obliquely against it; for the point which may penetrate directly through many inches of armor without injury may be fractured by a very slight transverse blow. See *Projectiles* and *Steel Projectiles*.

CHILL-HARDENING.—A mode of tempering steel cutting-instruments, by exposing the red-hot metal to a blast of cold air.

CHILLINGWORTH BAYONET.—The peculiarity of the essential feature of this invention, viz., the handle, consists in its affording a more convenient grasp for the hand in digging, or in using it as a side-arm, than does the ordinary bayonet-socket, without materially increasing its weight or losing the advantages of a secure fastening when it is fixed as a pike upon the gun. To secure this, besides the general shape of its profile, a shoulder is formed on the rearmost portion of the handle. To it is fitted a short sleeve, along the bore of which is cut a deep groove, intended to admit the bayonet-stud. When in fixing the bayonet on the musket the bayonet-stud strikes the shoulder, its longitudinal motion is arrested until the handle is turned



so that the square notch comes opposite to and receives the bayonet-stud; by then turning back the sleeve to its original position the bayonet is locked in place. By pushing back the pin through the bayonet-stud groove, the sleeve may be rotated until the stud which confines it comes opposite to the outlet of the internal circumferential groove in which it travels, when the sleeve may be slipped off. A catch-pin is kept in place by a transverse wire, and is pressed outward by a spiral spring. The blade and handle of the bayonet are forged in one piece. The curved neck of the handle is intended to be used as a muzzle-rest in firing, the point of the bayonet being then forced into the ground. See *Bayonet*.

CHIME.—The end of a tub or barrel. All powder-barrels are ordered to be rolled on the chime as being the safest mode of moving powder either in magazines or mill-houses.

CHINESE CAPSTAN.—A differential hoisting or hauling device, having a vertical axis, and therein only differing from the *differential windlass*.

CHINESE CROSS-BOW.—An ancient form of cross-bow, fitted with a case which turned on the stock by means of a lever moved by the wrist, and which furnished twenty arrows in succession, like our modern revolvers.

CHINESE FIRE.—A pyrotechnic composition consisting of gunpowder, 16 parts; niter, 8 parts; charcoal, 3 parts; sulphur, 3 parts; and cast-iron borings (small), 10 parts. See *Pyrotechny*.

CHINESE WHITE.—The white oxide of zinc has recently been introduced into the arts, under this name, as a pigment in place of the preparations of white-lead. It changes very little either by atmospheric action or by mixing with other pigments; but it has not the body of white-lead.

CHINESE WINDLASS.—A differential windlass in which the cord winds off one part of the barrel and on to the other, the amount of absolute lift being governed by the difference in the diameters of the respective portions. It is a good contrivance in the respect that great power may be attained without making the axle so small as to be too weak for its work. See *Chinese Capstan*.

CHINOOK.—The number of words constituting the *Jargon* proper does not exceed six hundred, and many of these are already obsolete or confined to certain limited localities. Not more than two hundred words of the *Chinook Language* proper are used in the *Jargon*, the balance coming from the Cree, Chehalis, Yakima, Klickitat, and various other Indian languages. In the *Chinook Jargon* the same word is frequently used as a noun, verb, etc., and generally has different meanings, according to the context; as, *lo-lo* (meaning whole, to earn, earnings, to carry and to conquer). Besides the words purely Indian, there are many derived from the Canadian French, and the following English words of easy pronunciation: *comb, haul, hook, house, lazy, man, musket, nose, sail, salt, ship, shoes, shot, sick, skin, smoke, soap, spoon, stick, stone, Sunday, tea,* and *wind.* The following are very common expressions: *Ab-ba,* well then; *Al-ah,* expressing surprise; *Au-ah,* expressing pain; *Kweesh,* an obstinate refusal. The *Chinook Jargon* is thoroughly understood by all Indians of the Northwest, and it is believed that a study of the following vocabulary, taken from FARROW'S MOUNTAIN SCOUTING, will enable any one to converse with any of the tribes. A great deal will depend upon the expression and gestures of the speaker, and experience only can teach him to intelligently say the most while using the fewest words.

Jargon Vocabulary. English—Chinook.

A

Above, sàh-a-le.
Absolve, mam-ook stoh.
Acorns, kàh-na-way.
Across, in-a-tl.
Afraid, kwash.
After, kim-tah.
Again (a so, more), weght.
Ague, colè-sick.
Ah! (admiration) wàh.
Ah (in pain), à-nah.
Alike, cock qua.
All, kon-away.
Almost, wake-siàh.
Alms (to give), mam-ook kla-how-i-am.
Alone, copet-ict.
Although, kegh-ti-chle.
Always, kwà-ne-sum.
American, Boston man.
Amusement, heè-hee.
And (then, besides, or) pee.
Angel, tà-màn-à-wis.
Angry, sollux.
Another, hul-o-ima.
Apple, le pome.
Apron, ki-see.
Arbutus, lahb.
Arm, le mah.
Arrive at, ko.
Arrow, kah-li-tan.
As, kock-wà.
As if, kàh-kw a, spose.
Ascend, clàt-à-wà sàh-a-le.
Ash-tree, is-ick-stick.
Ask (to), wà-wà.
At, kò-pa.
Aunt, kwalh.
Autumn, ten-as cole illà-he.
Awl, shoes keep-wot.
Axe, la hash.

B

Back, kimp-tà.
Bab, me-sà-chie.
Bad odor, humm.
Bad Spirit, mà-sà-chi tamàn-à-wis.
Bag, le sàk.
Ball, col-li-ton.
Bargain, ma-kook.
Bark, stick-skin.
Barrel, ta-mo-litsh.
Basket, ò-pe-kwan.
Be still, cul-tas mit-lite.
Beads, kà-mò-suck.
Bear (to), chet-woot.
Bear, its-hoot.
Beard, cha-pootch-us.
Beat (to), kok-shet.
Beaver, ce-naa.
Because, keh-wa.
Become (to), cha-ko.
Before, e-lip.
Behind, kim-ta.
Bell, tin-tin.
Belly, ya-kwah-tin.
Below, keè-kwil-lie.
Belt, là san-jel.
Berries, o-lil-lie.
Best, e-lip klosh.
Beyond, ten-às si-ah.
Big, hy-as.
Bird, kal-lak-a-la.
Biscuit, la bis-ke.
Bitter, klihl.
Black, klale.
Blackberries, klik-a-muks.
Blanket, pa-see-sie.
Blind, ha-lo see-à-host.
Blood, pil-pil.
Blow, puk-puk.
Blow out, mam-ook-poh.
Blue (light shade), spò-oh.
Blue (dark shade), klale.
Blunder (to), tsee-pie.
Bob-tailed, sis-ki-you.
Boil (to), lip-lip.
Bone, stone.
Boots, stick shoes.
Bore a hole (to), mam-ook thlà whop.
Borrow (to), a-yah-whul.
Both, kon-a-moxt.
Bottle, la-boo-ti.
Bow (of a boat), nose.
Bow (to shoot with), stick musket.
Bow, o-pitl-kegh.
Bowl, oos-kan.
Box, la ca-sett.
Boy, ten-as man.
Bracelet, klik-wal-lie.
Brass, pel chick-a-min.
Brave, skoò-kum tum-tum.
Bread, pia sa-pa-lil (san-de-lià).
Break, kok-shet.
Breast, to-toosh'.
Bridle, la bleed.
Bright, te-wagh.
Bring (to), màm-ook chà-co.
Broad, kluk-ulh'.
Broken, cha-cluck.
Brother, kàp-ho, if older than the speaker; ow, if younger.
Brother-in-law, ek-keh.
Brook, ten-às chuck.
Broom, bloom.
Bucket, ta-mò-litsh.
Buffalo, moos-moos.
Bullet, le bal, or ke-li-li-tan.
Bundle, kow.
Burn (to), mam-ook pia.
Biscuit, la-bisque.
But, pee.
Butter, to-toosh-la-klees'.
Button, chil-chil.
Buttons, tsil-tsil.
Buy (to), mah-kook.
By, co-pa.
By-and-by, win-a-pie.

C

Cabbage, cabbage.
Call (to), wà-wà.
Calf, ten-as moos-moos.
Calm (a), ha-lo wind.
Candle, la shan-del.
Canoe, ca-nim.
Cap, se-ah pult.
Capsize, kil-à-pie.
Carrot, la-ca-lat.
Carry (to), lo-lo.
Cart, tsik-a tsik.
Cascade, tum-wa-ter.
Cask, ta-mo-litch.
Cat, puss-puss.
Cataract, tum wa-ter.
Cattle, moos-moos.
Cedar, là med-cine stick.
Cellar, ket-wil-là.
Certainly, na-wit-kà.
Chain, chick-à-min lope.
Chair, la shase.
Change (to), huy-huy.
Cheat (to), là-lah.
Chicken, la pool.
Chief, ty-eè.
Child, ten-as man.
Chilly, ten-as cole.
Chimney, la-shum-ma-na.
Circle, que-u-que-u.
Clams, ò-na (emet-oks).
Clear, klah.
Clock, hy-as watch.
Cloth (dark), its-hoot.
Clouds, smoek.
Coat, ca-po.
Coffee, kau-py.
Cold, cole.
Color, 'tsum.
Come on, hy-ak.
Come (to), chà-co.
Come here, chà-co yockwa (ne-whàh).
Command (to), wà-wà.
Conceal, ipsoot.
Conjuring, ta-ma-na-wis.
Conquer (to), lo-lo.
Cook, mam-ook muck-a-muck.
Cool (to) mam-ook cole.
Copper, pil chick-à-min.
Cord, ten-as lo-pe.
Corn, ye-salth.
Corral, kul-lagh.
Cotton goods, sail.
Cough, hoh-hoh.
Count (to), mam-ook kwun-num.
Cow, clooch-man moos-moos.
Country, il-la-hè.
Coyote, tal-a-pus.
Crab-apple, pow-itsh.
Cranberry, so-le-mie.
Crazy, pelton.
Cream-colored, la clem.
Crooked, ky-wà.
Cross, là clo-a.
Crow, càw-càw.
Cry (to), cly.
Cup, oos-kan.
Curly, hunl-kih.
Cut (to), tl-ko-pe.

D

Dance, tanse.
Dark, polàk-lie.
Daughter, ni-ka ten-as clooch-man.
Day (this), o-kook sun.
Daybreak, ten-as sun.
Dead, mem-à-loos.
Deaf, ik-pooie kwil-lan.
Dear, hy-as mà-kook.
Deep, klip.
Deer, mow-itsh.
Demon, skoo-kum.
Desert (to sneak off), swal-là clat-à-wà càp.
Devil, deaub.
Different, kull.
Dig (to), mam-ook il-l.
Dirty, pot-tle il-la-he.
Dish, os-cun (plural la plà).
Dive (in water), clàt-a-wà keg-willy chuck.
Do (to), mam-ook.
Doctor, doc-tin.
Dogs, kam-ooks.
Dollar, dol-la.
Door, la pò-te.
Down stream, mi-mie.
Drink, mam-ook chuck.
Drive (to), kish-kish.
Drunk, pot-tle lum.
Dry, sun (dly).
Duck, kul-lak-a-la.
Duck (Mallard), hàht-huht.
Dust, pol-lal-lie.

E

Eagle, chak-chak.
Ear, kwo-lann.
Early, ten-as sun.
Earn, lo-lo.
Earth, il-la-he.
Eat (to), muck-a-muck.
Egg, la sap.
Elk, moo-luck.
Embrace, ba-ba.
Empty, ha-lo mit-lite.
Enclosure, kul-làgh.
End, o-boot.
Enemy, me-sa-chie til-la-cums.
Englishman (woman), King Gawge man (clootch-man).
Enlarge, hy-as mam-ook.
Enough, hy-u, or co-pet.
Entrails, ki-yah.
Evening, ten-as polak-lie.
Every, kon-a-wà.
Exchange, huy-huy.
Extinguish, mam-ook mem-a-loos (poh).
Eyes, see-a-host.

F

Face, see-a-host.
Fade (to), cha-co spo-ak.
Faded, spo-oh.
Falsehood, klim ia-a-whit.
Falsify (to), cla-man-a-whit.
Far, si-ah.
Far off, sy-àh.
Fast (quick), hy-ak.
Fast (tight), kwatl.
Fasten (to), kow.
Fat, glease.
Fat (to), hy-às gleece.
Father, pa-pa.
Fathom, it-lan (eth-low).
Fear, kwass.
Feet, là pe-à.
Fell (to), mam-ook-whim.
Fence, kul-lagh.
Fetch, mam-ook cha-ko.
Fever, waum sick.
Few, ten-as.
Field, klosh il la-he.
Fight (to), mam-ook sol-lux.
Fight (with fists), mam-ook puk-puk.
Figured, tzum.
File, la-leem.
Fill (to), mam-ook pahtl.
Find (to) klap.
Finished, co-pet.
Fingers, le doo.
Fire, pi-a.
First, e-lip.
Fish, pish (sa-mon).
Fish-hook, ik-kik.
Flag, Sun-day.
Flea, en-e-poo.
Flesh, il-wil-lie.
Flies, le moose.
Flint, kil-it sut.
Flour, sap-o-lil.
Flowers, klosh tip-so.
Fly (to), ka-wak.
Fog, smoke.
Food, muck-a-muck.
Foot, le-pee.
For what, pe-co-tu.
Forever, kwah-ne-sum.
Forenoon, èlip sit-cum sun.
Forget, copet cum-tux (mah-lie.)
Fork, la poo-shet.
Formerly, au-kot-tie.
Fox, tà-la-pos.
Frenchman, pa-si-ooks.
Friend, six.
Frog, swàh-kuk.
Fry (to), mam-ook la po-el.
Frying-pan, là po-el.
Full, pahtl.

G

Gallop (to), kwa-lal kwa-lal.
Gamble (to), ith-el-coom.
Gather (to), ko-ko-mulh.
Get (to), is-kum.
Get out, mash.
Get up, ket-op.
Ghost, skoo-kum.
Gift, cultus pot-lotch.

Girl, ten as clooch-man.
Give (to), pot-latch.
Glad, kwarm.
Glass, she-lockum.
Go, clat-a wà.
Go to bed, clat-a-wà moo-sum.
God, sa hà-lie ty-ee.
Gold, pil chick-a-min.
Good, klosh
Good-bye, kla-how-i-am.
Goods, ic-tas.
Goose, kàl-àk à-làh.
Grandfather, chope.
Grandmother, chitz.
Grass, tip-so
Grease, gleese.
Great, hy-as
Great many, hy u.
Green, pe-chugh.
Grey, le-gley.
Grizzly bear, se-àm.
Ground, il-la-he.
Gum-wood, là goom-stick.
Gun, suk-wal-lal.

H

Hail, cole-snass.
Hair, yak-so.
Half, sit-cum.
Hallo, nah.
Hammer, le-mah-to.
Hand, le-mah.
Hand (game of), it'lo-cum.
Handkerchief, kak-at-chum.
Handsome, hy-as klosh.
Hard, kull.
Hare, kwit-shad ie.
Harrow (to), mam-ook comb il-la-he.
Hat, se-ah-po.
Hazel nuts, tuk-wil-la.
He (she, it, his, etc.), yak-ka.
Head, la tet.
Heart, tum-tum.
Heaven, sà-hà-lie il-là-he.
Help (to), mam-ook e-lan.
Hell, ket wlt-là pià-hy-as.
Hen, la pool.
Here, yock-wa.
Hide, skin.
Hide (to), ip-soot.
High, sà-hà-lie.
Hit (to), kwulh.
Hoe, là-pe osh.
Hog, co-sho.
Hole, kla-wop.
Holiday, Sunday.
Horn, stone.
Horse, cu-l-tan.
How, kàh-tah.
How large? kon-si-ah.
How many? kon-se-à.
Hundred, tuk-a-mo-nuk.
Hungry, o-lo.
Hurry, hy-àk.
Husband, man.

I

I (me, my, or mine), ni-kà.
Ice, cole chuck.
If (suppose), spose.
In, ko-pà.
Indian, si-wash.
Indian corn, e-salth.
In shore, maht-wil-lie.
Iron, chick-a-min.
Island, ten-às il-la-he.
It (this, that), o-cook.

J

Jealous, sick tum-tum.
Joke (to), mam-ook làh-làh.
Joy, u-a-tle.
Jump (to), sò-pe-na.

K

Kamass root, là kà-mas.
Keep off (to), maht-lin-nie.
Kettle, ket-ling.
Key, la kley.
Kick (to), chuck-kin.
Kill (to), mam-ook mim-a-loos.
Kiss, be-be.
Knife, ò-pit-sah.
Knock (to), kò-kò.
Knotty, huul-kih.
Know (to), cum-tux.
Know (not to), wake cum-tux.

L

Lad, ten-as man.
Lame, klook te-hà wit.
Lamprey eel, skwák-wàl.
Land, il-la-hè.
Land otter, in-a mooks.
Language, là làng.
Large, hyas.
Last (hindermost), kimpta.
Lately, ten-às an-cot-tà.
Laughter, hee-hee.
Leap (to), sò-pe-na.
Leaf, tip so.
Lean (to), lagh.
Leave (to), mahsh.
Leave off (to), ko-pet.
Leg, te-ah-wit.
Leggings, mi-tas (sa-kol-eks).
Lend (to), a-yah-wuhl.
Length, youtl-kut.
Lick (to), kla-wun.
Lie (to), kla-man-a-wit.
Lift (to), mam-ook sa-ha-le.
Light (not heavy), wake-till.
Light (daylight), sun or twà (not dark), na wà.
Lightning, sa-ha-le pi-à.
Like, ka-kwa.
Like (to), tik-egh.
Listen (to), ne-whà.
Little, ten-as.
Live (to), mit-lite.
Liquor, lum.
Long while ago, là-lee.
Long, youtl-kut.
Long ago, an-cot-tie.
Look, nan-itch.
Looking glass, she lockum.
Loose, stoh.
Lose the way (to), tso-lo.
Lost, mash.
Love (to), tick-egh.
Lower, mam-ook-keg-wil-le.

M

Mad, sol-lux.
Magic, tà mà-nà-wàs.
Make (to), mam-ook.
Many, hy-u.
Mark, tsum.
Mark (to), mam-ook tsum.
Marry (to), ma-li-egh.
Mass (ceremony of), la mess.
Mast, ship stick.
Mat, klis-kwis.
Mattock, la peosh
Measure (to), ta nim.
Meat, itl-wil-lie.
Medicine, là med-sin.
Men, til-li-cums.
Mend (to), mam-ook tip-shin.
Metal, chick-à-min.
Middle (the), kat-sik.
Mid-day, sitcum sun.
Midnight, sit-cum po-làk-lie.
Milk, to-toosh.
Mind (the), tum-tum.
Mire, weght.
Miss (to), seè-pie.
Mixed, tzum.
Moccasins, skin-shoes.
Molasses, me-las.
Money, chick-a-min.
Month, moon.
Mosquito, mel-a-kwa.
Mother, ma mà
Mountain, la monti.
Mountain, hy-as il la-he.
Mouse, hool-hool.
Mouth, la boss.
Much, hy-u.
Mud, cle-min il-la-he.
Mule, la mel.
Music, tin-tin.
Mussels, to-luks.
Muskrats, cul-tus c-nah.
My (mine), ni ka.

N

Nails, le clou.
Name, yah-hul (nem).
Near, wake si-ah.
Neck, le cou.
Needle, ca-pu-ut.
Never, wake con-sè-àh.
Night, po-lak-lie.
No (not), wake.
Nobody, wake clax-to.
Noise, là tlah.
None, ha-lo.
Nonsense, cul-tus wa-wa.
Noon, sit-cum sun.
Not yet, wake al-ta.
Nothing, wake le-ta.
Notwithstanding, kegh-tchie.
Now, al-ta.
Nuts, til-wil-la.

O

Oak, kull stick.
Oar, la lahm.
Oats, la wen.
Obtain, is-kum.
Ocean, salt-chuck.
Off, klak.
Off shore, mahtl-in-nie.
Oil, gleece (la-kles.)
Old man, ole-man.
Old woman, lam-mi-ch.
On, co-pa.
One eyed, ict see-a-host.
Only, co-pet, ok-kook.
Open, hah-lakl.
Open (to), he-luck.
Opposite, in-a-ti.
Or, pe.
Order (to), mash tum-tum.
Other, hul-o-i-ma.
Otter, e-mam-ooks.
Our (we, us), ne-si-ka.
Out doors (outside), klagh-a-nie.
Over (above), sah-hà-lè.
Over (other side), en-a-ti.
Overcoat, ka po.
Ox, moos-moos.
Oysters, chet-lo.

P

Paddle, is-ick.
Paddle (to), mam-ook is-ick.
Paint, pent.
Paint (to), mam-ook pent.
Pants, se-ca-luck.
Path, o-e-hut.
Paper, pè-pah.
Peas, le pwan.
People, til-li cums.
Perhaps, klo-nas.
Petticoat, kal-a-kwah-tie.
Piebald, le kye.
Pin, kwek-wi-eus (keep-wot).
Pipe, la peep.
Pitch, la goom.
Plate, la se-et.
Plough (to), klugh il-la-he.
Pole, le pehsh.
Poor, ha-lo le-ta (kla-how-yam.)
Pork, co-sho.
Porpoise, qui-see-o.
Potato, wap-pa-to.
Pour (to), wagh
Powder, po-lal-lie.
Prairie wolf, tul-a-pus.
Present (a), cul-tus pot-latch.
Presently, al-kie (win-a-pie.)
Pretty, to-ke-ti.
Priest, le plet.
Proud, youtl (kwelth).
Provided that, spose.
Pull, haul.
Push, kwult.

Q

Quarter, ten-as sit-cum.
Quarter (of a dollar), kwahta.
Quick, hy-ak.
Quills, te-peh.

R

Rabbit, kwit-shad-ie.
Rain, snass.
Rat, holé holé.
Rattle, shugh.
Rattlesnake, shugh-ò-poots.
Razor fish, ò-na.
Reach, ko.
Red, pil.
Relate (to), yi-em.
Report (of a gun), poo.
Return, cha-co kil a-pie.
Ribbon, le lo-ba.
Rice, mit-whit.
Rifle, ca-li-peen.
Ring (a), kwèo-kwèo.
Ripe, pi-ah.
River, hy-as chuck.
Road, way-hut (o-chut).
Roan-colored, san-de-lie.
Roast, mam-ook la pellah.
Rock, stone.
Rooster, la cock.
Root, ka-mass.
Rope, lope.
Rotten, poo-lie.
Round, lo-lo.
Row (to), mam-ook le-lam.
Rudder, boat-o-poots.
Rum, lum.
Run, coo-ry.
Run away, cap-swal-la clat-a-wa.

S

Sack, le sak.
Saddle, la sell.
Saddle-housing, le-pish-e-mo.
Sailor, ship-man.
Salmon, sà-mon.
Sand, po-lal-lie.
Sandwich Islander, Oyee.
Sash, la saw-jel.
Saw, la see (la gwin).
Say (to), wa-wa.
Scarce, quass
Scissors, le see-zo.
Sea, salt chuck.
Seal, ol-hi-yu si-wash co-sho (ol-hy-in).
See (to), nan-itch.
Sell (to), mah-cook.
Send (to), clat-a-wà.
Sew (to), mam-ook tip-shin.
Shake, hul-hul.
Shake (to), to-to.
Shame, shem.
Sharp, pah kis-ilth.
Sharpen to), mam-ook tsish.
She, ya-ka.
Sheep, le mon-to.
Shell money (small), coop-coop.
Shell money (large) ai-qua.
Shingle, le bah-do.
Shining, to-wagh.
Shirt, shut.
Shoat (to), mam-ook poo.
Short, yutes-kut.
Shot-pouch, kl-li-tan le-sac.
Shout (to), hy-as wa-wa.
Shovel, la-pell.
Shut (to), ik-poo-ie.
Sift (to), to-to.
Silk, la-sway
Silver, t-kope chik-a-min.
Similar, kah-kwa.
Since, kim ta.
Sing (to), shan ti.
Sink, cli-a.
Sister (elder), lik-po.
Sister (younger), ats.
Sit (to), mit-lite.
Skunk, hum-o-poots (saub-bno).
Sky, kon-sah.
Slave, e-li-te (mist-chi-mas).
Sleep, moo-sum.
Slowly, kla-wa.
Small, ten-as.
Smell, hum.
Snake, o-luk.
Snare, la pe-nge.
Snow, cole-snass.
Soft, cla-min.
Sometimes, ict-ict.
Soon, wake le-ly.
Sorrell (color), le-blau.
Sorry, sick tum-tum.
Sour, kwates.
Spade, la pell.

Speak (to), wà-wà.
Spill (to), wagh.
Spirit (guardian), to man-no-us.
Spirits, lum.
Split, tsugh.
Split (to), mam-ook tsugh.
Spectacles, dal-la see-a-host.
Spit (to), mam-ook toh.
Spotted, le-kye.
Spurs, la see-blo.
Squirrel, kwis-kwis.
Stab (to), klem-a-hum.
Stag, man-mow-a-itch.
Stand, mit-whit.
Stars (buttons), tsil-tsil.
Stay (to), mit-lite.
Steal, cap-swalla.
Steam, smoke.
Steamer, ship (pia-ship).
Stirrup, sit lay.
Stockings, kush-is.
Stop, ko-pet.
Store, ma-cook house.
Story, eh-kah-nam.
Straight, si-pah (de-làte).
Strawberries, a-mo te.
Strike (to), cock-shet.
Strong, skoo-kum.
Sturgeon, stutch-un.
Subdue, quan.
Sugar, le sook.
Summer, waum il-la-he.
Sun, Otà-lagh.
Sunset, elip-sun.
Suppose, spose.
Swan, kah-loke.
Sweep (to), mam-ook bloom.
Sweet, tsee.
Swim, sit-shum.

T

Table, la tahb.
Tail, o-poots.
Take (to), iskum.
Take care, klosh nan-itch.
Take off, mam-ook klak.
Tale, yi-em.
Talk, wà-wà.
Tame, kwass.
Tattle (to), ya-yim.
Teach (to), mam-ook-cum tux.
Tear (to), klugh.
Teeth, le tah.
Tell (to), wà-wà.
Thank you, màh-sie.
That, o-cook.
That way (there, beyond), yah-wa.
They, klas-ka.
Thich, pit-lilh.
Thin, pe-what-tie.
Thing, ic-ta.
Thirsty, o-lo chuck.
This, o-cook.
This way, yàk-wà.
Thou (thy, thine), mi-kà.
Thread, kla-pite.
Throw (to), mash.
Throw away, mahsh.
Tide, chuck.
Tie (to), kow.
Tight, kwutl.
Tinware, ma-lah.
Tip (to), lagh.
Tired, till.
To (towards), ko-pa.
Tobacco, ki-noos.
To-day, o-cook sun.
To-morrow, to mà-tà.
Tongue, la lang.
Trade (to), hoè-hoè.
Trail, way-hut.
Trap, la piege.
Tree, stick.
Tree (fallen), whim stick.
Tremble, hul hul.
Trot (to), teh-teh.
Trouble, mam-ook till.
Trowsers, so-kol-eks.
True, de-làte.
Truth, de-làte wà-wà.
Tub, ta-mò-litsh.
Turn (to), howh.
Turn over (to), kil-à-pie.
Twice, moxt.
Twilight, twàh.
Twine, ten-as lope.

U

Uncle, tot.
Under, kee-kwil-lie.
Understand (to), cum-tux.
Unhappy, sick tum-tum.
United States, Boston il-la-he.
Untamed, le mo-lo.
Untie (to), mam-ook stoh.
Up (above, heavenward) sa-ha-lie.
Upset (to), kil-a-pi.
Us, ne-si-ka.
Useless, cul-tus.

V

Vancouver, kits-oat-qua.
Venison, mow-itch.
Very small, hy-as ten-as.
Vessel, ship.
Vest, la west.
Vomit (to), wagh.

W

Wagon, chik-chik.
Wander (to), ts-o-lo.
Warm, waum.
Wash (to), mam-ook wash.
Watch, tik-tik.
Watch (to), nàn itch.
Water, chuck.
Waterfall, tum-water.
We, ne si-ka.
Week (one), ict Sunday.
Weigh (to), mam-ook lil.
Wet, pahtl-chuck.
Whale, eh-ko-lie.
What, ic-ta.
What color? kà-tà tsum.
Wheat, sap-o-lil.
Wheel, chik-chik.
When, kan-sih.
Where, kah.
Whip, la whet.
White, t-kope.
Who, klax-ta.
Whole, lo-lo, kwa-nice.
Wicked, me-sa-chie.
Wide, kluk-ulh.
Wild, le mo-lo.
Will (the), tum-tum.
Willow, ee-na stick.
Win (to), to-lo.
Winter, cole il-la-he.
Wipe (to), klak-wun.
Wire, chik-a-min lope.
Wire (brass), klik-wal-la
Wish (to), tick-ey.
With, co-pa.
Without, ha-lo.
Wolf, le-loo.
Woman, clootch-man.
Woman (old), lam-mi-eh.
Wood, stick.
Work (to), mam-ook.
Worn out, ol-è-man.
Worthless, cul-tus.
Wound (to), klem-a-hum.
Write (to), mam-ook tsum.
Writing, tsum.

Y

Year (a), ict cole.
Yellow, kaw-ka-wak.
Yes, ah-ha.
Yes indeed, na-wit-ka.
Yesterday, tahl-kie sun.
Young, ten-as.
You, mi-ka.
Yours, me-sika.

NUMERALS.

One, ict.
Two, moxt.
Three, klone.
Four, lak-it.
Five, kuin-num.
Six, tagh-hum.
Seven, sin-à-moxt.
Eight, sto-te-kin.
Nine, kweest.
Ten, tah tel-lum.
Twenty, moxt tah-tel-lum.
Thirty, klone tah-tel-lum.
One hundred, ict ta-kà-mo-nuk.
One thousand, tah-tel-lum ta-ka-mo-nuk.

Greater numbers are expressed by a conjunction of the words expressing the numbers to be added, thus: Sin-a-moxt tah-tel-lum (seven times ten) express seventy.

THE LORD'S PRAYER IN JARGON.

Our Father who stayeth in the above, good in our hearts (be) thy name; good thou chief among all people; good thy will on earth as in the above; give every day our food; If we do ill, (be) not thou very angry, and if any one evil towards us, not we angry towards them; send away far from us all evil.

Ne-si-ka Papa klax-ta mit-lite ko-pa sà-ha-lie, klosh ko-pa ne-si-ka tum-tum mi-ka nem; klosh mi-ka ty-ee ko-pa kon-a-way lil-li-cum; klosh mi-ka tum-tum ko-pa il-la-he kah-kwo ko-pa sa-ha-lie; pot-latch kon-a-way sun ne-si-ka muck-a-muck; Spose ne-si-ka mam-ook me-sà-chie wake mi-ka hy-as sollux, pee spose klax-ta me-sà-chie ko-pa ne-si-ka, wake ne-si-ka sollux ko-pa klaxta; mahsh si-ah ko-pa ne-si-ka kon-a-way me-sà-chie.

CHIN-STRAP.—1. The strap connecting the throat-strap and the nose-band of a halter. 2. A strap passing under the chin, employed to hold the helmet or dress-hat in place in windy weather.

CHIVALRY.—The system of knighthood, together with the privileges, duties, and manners of knights. The social arrangement to which this term is applied seems first to have assumed the character of a positive institution during the eleventh century; but so far from being an invention of that period, it had its roots in the manners of the Germanic races, amongst whom it ultimately arose, at the earliest period at which they are historically traceable. In the description which Tacitus has given us of the manners of the Germans we find the most unequivocal indications of the existence, not only of the general spirit, but, in a partially developed form, of many of the special arrangements of chivalry. But it was in connection with feudality that chivalry attained to its full proportions, and in many respects it must be regarded as the complement of that institution. Whilst feudality exhibits the political, in chivalry we see the moral and social side of the arrangements of mediæval life. It was in the feudal mansions of the barons that the system was developed; and to the lay portion of the youth of the higher classes the instruction which they there received in the usages of chivalry formed by far the most important part of education. In addition to the martial accomplishments, which corresponded to those of a modern cavalry-officer, they were instructed in the political relations which subsisted between the vassal and his lord, by which the whole body of society was then bound together; and in what might almost be called a system of ethics, strangely enough exhibiting unmistakable traces of the Stoic philosophy. The analogy between the severer virtues recommended to the special cultivation of their disciples by the followers of Zeno, and those inculcated on the novice in chivalry, and practiced by the knights of the Middle Ages, might be ascribed to other than historical causes, were it not that we are able to trace the connection between them with something approaching to certainty. If any one wishes to convince himself of the truth of our assertion, let him compare the last production of the intellectual life of antiquity with one of the earliest and most important of our own literature —the *Consolations of Philosophy* of Boethius with Chaucer's *Testament of Love*. The resemblance is so close that the latter work has, not without reason, been regarded as an imitation of the former; but the main features which distinguish them, and mark Chaucer's work as belonging to the modern world, are more instructive than even their similarity. What Chaucer has exhibited in the work to which we have referred may be regarded rather as the philosophical than the poetical side of the institution. But to poets of a lighter and more imaginative cast of mind chivalry has furnished, from the days of the troubadours down to the present Poet-laureate, no insignificant portion of their subject-matter. King Arthur and his Knights of the Round Table, the traditions regarding whom had been taken from a period altogether mythical and long anterior to the existence of chivalry as an institution, became to the poetry of the Middle Ages very much what the heroes of the Trojan War were to that of the whole ancient world. Much astonishment has often been expressed at the contrast between the lofty and ideal purity of the code of morals inculcated by chivalry, and the grossness of the lives of the men who were trained under its influences. The case is one which in a remarkable degree proves the practical importance of the inculcation of sound doctrine, for the practice gradually, though slowly, conformed itself to the principles; and it is probably in no insignificant degree to the elevated tone of the latter that we owe the moral superiority of the modern over the ancient world. See *Court of Chivalry*.

CHLORATE OF POTASSA.—Many oxydizing substances, such as the chlorate of potassa and nitrate of soda, may be used in the manufacture of gunpowder; but for this purpose they are inferior to the nitrate of potassa. The chlorate of potassa is a substance which parts with its oxygen easily, and makes a powder which has been found by experience to give at least double the range, with the mortar eprouvette, of that made with nitrate of potassa, but from its great quickness resembles the fulminates in its destructive effects on the gun. Besides, it is more costly than nitrate of potassa, renders the powder liable to explode by slight causes, and gives a residue which rapidly corrodes iron. Its use in the laboratory is chiefly confined to the preparation of colored fires and cannon-primers.

Chlorate mixtures are very sensitive to friction and percussion, and they explode with great sharpness. The potassium salt is the only one of the chlorates which is employed in these mixtures. Very many chlorate mixtures have been made, but few of them are of much value. Of many of them it may be said that they are so liable to accidental explosion that they are unfit for use. The following are examples of chlorate mixtures: potassium chlorate with rosin; potassium chlorate with galls (Horsely's powder); potassium chlorate with gambier (Oriental powder); potassium chlorate with sugar (used in chemical fuses); potassium chlorate with potassium ferrocyanide (White or German gunpowder); potassium chlorate with tannin (Erhardt's powder); potassium chlorate with sulphur (Pertuiset powder, used in explosive bullets). In the laboratory, however, potassium chlorate is the basis of many fuse-mixtures, some of which are used to a certain extent. See *Gunpowder*.

CHOCK.—A piece of wood by which the wheel of a carriage is prevented from moving forward or backward. In the United States Ordnance Department two kinds are employed, the simplest form being triangular in section, while another description of chock is wedge-shaped and provided with a handle. A common form of chock is attached to cast-iron garrison-carriages, on which the breech of the gun rests and is elevated.

CHOCKING HANDSPIKE.—A handspike employed when slewing a gun that rests on skids, and in other mechanical maneuvers.

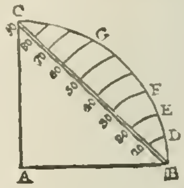
CHOKE.—1. A slightly narrowed part just in front of the chamber in certain guns, to insure that all projectiles are rammed to the same spot. 2. The tied end of a cartridge; also, the constriction of a rocket-case, etc.

CHOKER.—An instrument used for bringing the ends of a fascine to the girth, nearly where it is intended the fascine should be, when it is bound.

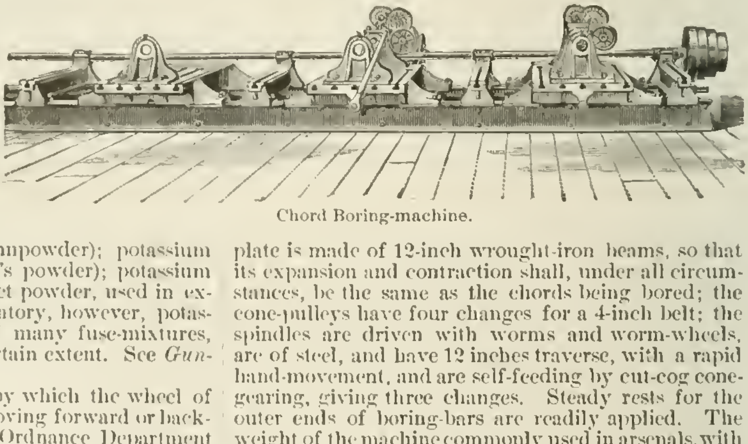
CHOKE-STRAP.—A strap passing from the lower portion of the collar to the belly-band, to keep the collar in place when descending a hill or backing.

CHOKEY.—A common expression for an East Indian guard-house and prison.

CHORD.—The chord of an arc of a curve is a right line joining its two extremities. A scale of chords is used in laying off angles. It is thus constructed: Let AB be the radius of the circle to which the scale is to be adapted. With the center A and radius AB describe a quadrant BEC. Divide the quadrantal arc BEC into nine equal parts BD, DE, etc. This may be done by taking a radius equal to AB, and from the centers B and C cutting the arc in G and F. As the radius is always equal to the chord of 60°, or $\frac{2}{3}$ of a quadrant, the arc CB is thus divided into three equal parts, BF, FG, GC, and each of these parts may then be trisected by trial, as no direct method is known. Draw the chord of the quadrant BC; from B as a center, and the chord of BD as a radius, describe an arc cutting BC at 10; with the chord of BE as a radius, describe an arc cutting BC in 20; with the chord of BF, describe an arc cutting BC in 30; and in a similar manner find the divisions 40, 50, 60, 70, 80. Then the arcs BD, BE, BF, being arcs of 10°, 20°, 30°, etc., respectively, the distances from B to 10, 20, 30, etc., are the chords of arcs of 10°, 20°, 30°, etc.; so that BC is a scale of chords for every 10°, from 0° to 90°. To lay down or measure angles with such a scale, the arc of 60° measurement must be described with the chord of 60°.



CHORD BORING-MACHINE.—A tool consisting of two horizontal boring-machines and an extra table to facilitate setting the work, so arranged that they can be adjusted and clamped on the bed-plate to suit the centers of the holes in the chords; it is of sufficient capacity to admit chords 3 feet by 2 feet; the bed-plate is made of 12-inch wrought-iron beams, so that its expansion and contraction shall, under all circumstances, be the same as the chords being bored; the cone-pulleys have four changes for a 4-inch belt; the spindles are driven with worms and worm-wheels, are of steel, and have 12 inches traverse, with a rapid hand-movement, and are self-feeding by cut-cog cone-gearing, giving three changes. Steady rests for the outer ends of boring-bars are readily applied. The weight of the machine commonly used in arsenals, with 55 feet of bed, is 32,200 pounds. See *Boring-machine*.



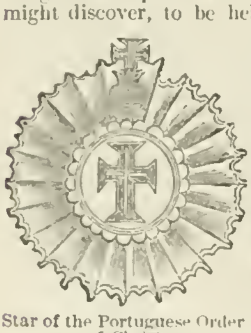
Chord Boring-machine.

CHOROGRAPH.—An instrument contrived by Professor Wallace, of Edinburgh, "to determine the position of a station, having given the three angles made by it to three other stations in the same plane, whose positions are known." The problem may be stated thus: To construct two similar triangles on two given straight lines.

CHOUANS.—Bands of insurgent royalists who, during the French Revolution, organized a reactionary movement in Brittany. They obtained their name from their leader, Jean Cottereau. This person, who had been a smuggler, went by the name of Chouan—a corruption, it is said, of *chat-huant* ("screech-owl")—because, while he and his accomplices were engaged in their nocturnal work, they were wont to be warned of their danger by some one on the watch imitating the cry of this bird. At the period of the revolt, however, he followed the humble occupation of a clog-maker. The first indications of an anti-revolutionary spirit in Brittany manifested themselves in the beginning of 1791, when several trees of liberty were destroyed at night, and other more serious outrages committed. These disturbances were fomented by seditious priests. In 1792 an insurrection was planned by the Marquis de la Rouarie, with the sanction and approval of the two brothers of Louis XVI. The agents of the Marquis entered into communications with Jean Cottereau—well known for the reckless audacity of his character—and other smugglers; but having the misfortune to be arrested, the carrying out of the insurrection devolved upon the latter. The *Chouanerie*, as the Insurrection was called, at first disgraced itself, both by the drunken license and the cruelty which marked it. After several successful exploits of the guerrilla sort, Jean Cottereau perished in an engagement which took place on the 28th of July, 1794, near the wood of Misdon, the theater of his first efforts. Before this, however, other and more illustrious leaders had appeared in Brittany to direct the movement, the chief of whom were Georges Cadoudal and Charette. Through their endeavors it was more widely extended, and for a time seemed likely to imperil the security of France, but was suppressed towards the close of 1799. Petty *spurts* of insurrection, however, broke out till about 1803, when the *Chouanerie* ceased for a while. In 1814–15 it again made its appearance on both sides of the Loire; and after the July Revolution, was once more excited by the Duchess of Berry on behalf of the Duke of Bordeaux, but crushed by the energetic measures taken by M. Thiers.

CHOUMARA SYSTEM OF FORTIFICATION.—Choumara, a French officer of engineers of distinguished abilities, is the author of several remarkable memoirs on the defects of the bastion system, and the means by which they may be removed and additional strength be thereby given to the defenses. His proposition for this purpose may be briefly stated as follows: 1. That part of a permanent work which can undergo no modification during the progress of a siege is the masonry, and it may therefore be regarded as the really permanent feature; all the parts of earth, as the parapets, etc., being susceptible of such modifications as circumstances may demand. In all cases of the application of the independence of the parapets, Choumara proposes to convert the space left between the foot of the parapet and the scarp-wall into a *chemin de ronde*, or corridor, which is covered in front by a slight parapet, and from enfilading fire by giving an increased height to the portion of the parapet adjacent to the salients, forming a *bonnet*. This corridor is occupied by sharp-shooters to annoy the besieger's trenches. Furthermore, Choumara regards the corridor as an additional security against surprise and escalade. 2. He proposes to place high traverses in the bastion-salients, to cover the faces from enfilade and the flanks from reverse views, and similar traverses at the shoulder-angles with the same object. These he also proposes to casemate, or else construct with blindages for artillery to obtain a fire in the directions of the capitals, and reverse views on the demi-lune glacis and the breach in the bastion-face. As these traverses, from their height, might give the besiegers in possession of them a plunging fire on the bastion-retrenchments, he proposes so to arrange them that they can be readily destroyed at any moment by mines, or, if of timber, be burned. 3. To mask the masonry of the enceinte and demi-lune from breaching-batteries, erected in their usual positions along the crests of the glacis, Choumara proposes to form what he terms an *interior glacis*, or covering mass of earth, in the ditches, the crests of which shall mask the masonry of the scarps from the positions in question; and the upper surface of which, forming a glacis, shall be swept by the fire of the works in its rear. In this manner he expects to force the besiegers to the difficult operation of making lodgments in this glacis to obtain suitable positions for their breaching-batteries. 4. By selecting for some of his outworks those points on the exterior which are most favorable to the action of the assailant's sharp-shooters, he proposes in this way to cripple this important means of attack. 5. By giving greater extent to the exterior side, and a more retired position to the curtain, which is also to be made as short as possible, Choumara obtains bastions of ample size, not only to admit of the modifications he proposes for the parapets, traverses, and *chemins de ronde*, but for strong interior retrenchments, so organized with bomb-proof shelters, and arranged defensively towards the interior, that each bastion will admit of a defense to the rear at its gorge, after the besiegers may have effected a breach at other points and penetrated within the enceinte. The essential modifications proposed by him may be summed as follows: detaching the scarp from the parapet; regulating the line of defense by the range of field-artillery, not musketry; introducing an interior glacis; and employing defensive barracks to serve as interior retrenchments. The memoirs in which Choumara brought his propositions before the public naturally attracted attention, as much, perhaps, from their polemical character and piquancy of style as their professional interest. They contain but few things the germs of which are not to be found in writers who preceded him. His modifications respecting the parapets, throwing them back from the scarps and breaking them into directions best suited for defense, are to be met with in Chasseloup's propositions. His proposals for lengthening the bastion-flanks and occupying the salient places-of-arms by redoubts with considerable command are to be found in the methods of De La Chiche. To Virgin he seems to be indebted for his organization of interior retrenchments, which are to convert each bastion into an independent work, equally provided for defense against approaches both from the interior and exterior of the enceinte. Like disputants, usually, of an ardent temperament, he overestimates the value of many of his propositions and loses sight of their countervailing defect. By laying down as a principle what may be exceptionally good in practice, he has rather weakened his own positions. This is the case, particularly, with his rule of independence of the parapets on the scarps, which, if adopted in all cases, might demand a greatly increased and hurtful command, and cut up to great disadvantage the interior spaces of the bastions. His introduction of the *chemins de ronde* on the faces of the bastion and the demi-lune adds really very little, if at all, to the exterior defense; whilst they contract the interior space of these works, break in upon the unity of the defense, and place the troops in them in a very exposed position to the means of annoyance possessed by the besieger. His expectations with respect to the effect of his fire in the direction of the capitals, in delaying the besieger's approach to the third parallel, were hardly warranted by the experience gained in artillery and small-arms, even at the time the last edition of his memoirs appeared. It is hardly to be questioned, now that these weapons have been so greatly improved, both in range and accuracy of fire, that, considering the increased development of the besieger's parallels, which gives him a choice of positions for his batteries on so extended a line, the concentrated fire he could bring to bear on the batteries in question would not only soon ruin their casemates, but would greatly damage the adjacent faces and also the flanks of the bastions, although covered from enfilading views, either by the direction of the parapets of the faces or the high traverses raised with the same object. These advantages in the position of the besieger, it is thought, would prevent any delay in pushing forward his approaches up to the third parallel. After this the approaches would probably be retarded beyond the usual time in the attack on Cormontaigne's front, owing chiefly to the redoubts in the bastion and demi-lune salient places-of-arms, and the arrangement of the face-cover in the enceinte-ditch. Supposing an enceinte organized according to his method, and containing interior retrenchments to oppose the besieger's approaches both from without and within the enceinte, Choumara estimates at least six separate epochs of breaching-batteries, as follows: 1st, against the redoubt of the demi-lune salient place-of-arms; 2d, against the demi-lune and the redoubt of the bastion salient place-of arms; 3d, against the bastions; 4th, against the bastion-retrenchment; 5th, against the retired retrenchment; 6th, and finally, against the bastions converted into citadels by the fronts with which their gorges are closed. According to the estimates of the time made by Choumara, it would require 112 days from the opening of the trenches to the final assault and reduction of last defenses. See *Fortification* and *System of Fortification*.

CHRIST.—The Portuguese Order of Christ has an interesting history. When the Templars were expelled from France, and their property confiscated by Philippe le Bel, with the sanction of Pope Clement V., they were received into Portugal, and their Order revived in 1317 under the title of "The Order of our Lord Jesus Christ." With some difficulty Pope John XXII. was induced to sanction the new order. The Knights of the Order of Christ joined the Portuguese in all their crusades against the infidel, and also in their African and Indian expeditions, receiving in compensation continual additions to their own possessions. The Grand Prior of the Order was invested by Pope Calixtus III. with power equal to that of a bishop; and as an encouragement to adventure, the Knights were promised all the countries which they might discover, to be held under the protection of Portugal. At length their wealth and power excited the jealousy of the kings of Portugal; their future acquisitions, and, subsequently, even their actual possessions, were declared to be Crown possessions, and the offices of Administrator and Grand-master were transferred to the Crown. A fine cloister belonging to the Order is still to be seen at Tomar, to which place the seat of the order was transferred from Castro-Marino in 1366. Noble descent, and three years' military service against the infidel, were required for admission. The members took the three monkish vows of chastity, poverty, and obedience, till the Pope released them from the first two, on condition of their applying the third part of their revenues to the support of Tomar cloister, the priests of which were bound by the three vows. This cloister is now a theological institution for the instruction of the priests of the Order. It is said that the Order still possesses 26 villages and farms, and 434 prebends. It is very numerous—consisting of six Knights of the Grand Cross, 450 Commanders, and an unlimited number of Knights. Catholics of noble descent alone are admitted, and foreigners are excluded from participation in the revenues, being exempted in return from its rules. The Papal Order of Christ is a branch of the Portuguese Order, created by Pope John XXII., and has only one class.



Star of the Portuguese Order of Christ.

CHRISTIAN CHARITY.—KNIGHTS OF THE ORDER OF CHRISTIAN CHARITY was the name of an Order instituted by King Henry III. of France for the support of maimed officers and soldiers who had done good service in the wars. He assigned revenues to the Order, drawn from all the hospitals in the kingdom. The Knights wore on the left breast an anchored cross embroidered on white taffety or satin, with a border of blue silk, and in the middle of the cross a lozenge of sky-blue charged with a *fleur-de-lis or*. The completion of the Institution was reserved for Henry IV., who placed it under the charge of the Marshals and Colonels of France; and by means of it, many of those who had served their country faithfully were enabled to spend the latter portion of their lives in peace and above want. The Order formed the germ of that noble hospital, the *Invalides*, which was founded by Louis XIV., and which served as a model for the English hospitals of Chelsea and Greenwich. When the Invalides was founded, the Order of Christian Charity was superseded.

CHROMATICS.—That part of the science of optics which explains the properties of the colors of light and of natural bodies. Before 1666, when Sir Isaac Newton began to investigate this subject, the notions which prevailed respecting the nature of colors were purely fanciful. Till Descartes' time, indeed, it seems not to have been conceived that color had anything to do with light. As examples of the notions prevalent at very early times, we may cite those propounded by Pythagoras and Zeno.

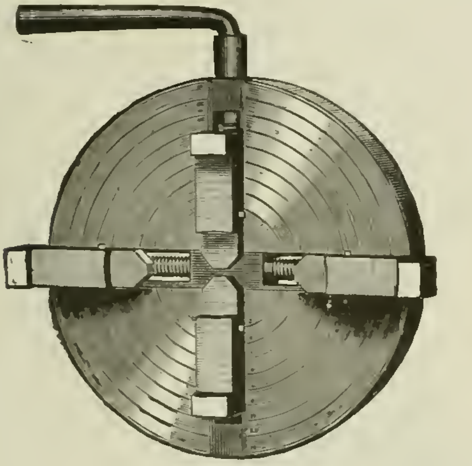
CHROMATYPE.—A photographic process, thus described by its discoverer, Mr. R. Hunt: One dram of sulphate of copper is dissolved in one ounce of distilled water, to which is added half an ounce of a saturated solution of bichromate of potash; this solution is applied to the surface of the paper, and when dry it is fit for use, and may be kept for any length of time without spoiling. When exposed to sunshine, the first change is to a dull brown, and if checked in this stage of the process we get a negative picture; but if the action of light is continued the browning gives way, and a positive yellow picture on a white ground is obtained. In either case, if the paper, when removed from sunshine, is washed over with a solution of nitrate of silver, a very beautiful positive picture results. In practice it will be found advantageous to allow the bleaching action to go on to some extent; the picture resulting from this will be clearer and more defined than that obtained when the action is checked at the brown stage. To fix these pictures it is necessary to remove the nitrate of silver, which is done by washing them in pure water. If the water contains any chloride, the picture suffers, and long soaking in such water obliterates it—or, if a few grains of common salt be added, the apparent destruction is rapid. The picture is, however, capable of restoration, all that is necessary being to expose it to sunshine for a quarter of an hour, when it revives; but instead of being of a red color, it assumes a lilac tint, the shades of color depending upon the quantity of salt used to decompose the chromate of silver which forms the shadow parts of the picture. Mr. Bingham suggested the substitution of sulphate of nickel for sulphate of copper, as yielding a higher degree of sensitiveness and greater definition. Neither process has been much used.

CHRONOGRAPH. — Different forms of time-measurers, or time-recorders, under this designation, have been invented within a recent period. Benson's chronograph is intended to measure intervals of time down to tenths of a second, for use at horse-races and other occasions where a seconds-watch is not exactly suited. It has an ordinary quick train-lever movement, carrying hands which move over a dial. One of these is a seconds-hand, very peculiarly made. The seconds-hand is double, consisting of two distinct hands, one superposed on the other. The outer end of the lowermost hand has a small cup with a minute hole at the bottom; while the corresponding end of the uppermost hand is bent over so as exactly to reach this puncture. The little cup is filled with ink having a consistency between that of writing-fluid and printers' ink. Suppose that a horse-race is about to take place. The observer keeps a steady lookout for the fall of the starter's flag, or whatever the signal may be: he gives a pull to a cord or string connected with the mechanism peculiar to the instrument; by this movement the outer and bent end of the upper seconds-hand dips down through the ink-cup in the lower hand, and through the puncture to the dial. A small black spot or mark is thus made upon the dial-plate; and this is repeated as each horse passes the winning-post. If the eye and hand of the operator are quick and accurate, there is a reliable record thus presented by the instrument of the duration of the race, sometimes as close as one tenth of a second. The instrument is now adopted at the principal races as a suitable one for the purpose; thus it is used for races such as the Derby, the Oaks, the Goodwood, the St. Leger, etc. It is also available for many other purposes. Strange's chronograph is designed for a more scientific purpose, and constructed with more careful details. The object is to measure extremely short intervals of time, for the determination of longitudes in great trigonometrical surveys. The observer, when a particular star traverses the field of his telescope, touches a small ivory key; and on the instant a dot or mark appears on a sheet of paper coiled round a barrel. The instrument being connected with an astronomical clock, there is a dot made for every beat of the pendulum; and as these dots are a considerable space apart (considerable, that is, for the refined instruments of the present day), it is possible to determine so wonderfully minute an interval as the one hundredth of a second. Other forms of chronographs have been adopted by astronomers. One was suggested by Professor C. A. Young in 1866 to assume the functions of a *recording* chronograph, by marking the instant of observation in hours, minutes, seconds, and hundredths of a second, in *printed* characters, and in a form suitable for preservation and reduction. Chronographs connected with electric and magnetic apparatus are used for determining the velocity of projectiles. Many forms have been devised by Noble, Bashforth, Navez, Le Boulengé, and other inventors. The most general arrangement consists in causing the bullet to pass through a series of screens; the rupture of each screen breaks for a moment the continuity of an electric current, sets in action an electro-magnetic apparatus, and makes a permanent mark or record. See *Chronoscope*.

CHRONOMETER.—The name given to a common form of time-measurer. The mechanism is essentially the same as that of a common watch; only the size is generally greater, and additional precautions are taken to secure regularity under changes of temperature and other deranging influences. See *Horology*.

CHRONOSCOPE.—An instrument contrived by Sir Charles Wheatstone to measure the duration of certain short-lived luminous phenomena, such as the electric spark, of which the eye itself can be no judge, owing to the persistence of impressions of light on the eye after the cause of sensation has ceased. The phenomenon is observed by reflection in a mirror, in such rapid motion that the image of the luminous object would appear to describe a circle, supposing the luminosity to endure long enough. Should the phenomenon be instantaneous, the image will appear as a mere point; should it last for an appreciable time, the image will form an arc, greater or less, of the circle. The electric spark is found by this test to have no duration. See *Bashforth Chronograph*, *Benton Thread-velocimeter*, *Electric Clepsydra*, *Le Boulengé Chronograph*, *Navez-Leurs Chronoscope*, *Noble Chronoscope*, and *Schultz Chronoscope*.

CHRYSOTYPE.—A photographic process invented by Sir John Herschel, and depending for its success on the reduction of a persalt of iron to the state of protosalt by the action of light, and the subsequent precipitation of metallic gold upon this protosalt of iron. The process is conducted as follows: Good paper is immersed in a solution of ammonio-citrate of iron of such a strength as to dry into a good yellow color, without any tinge of brown in it. It is then exposed to light under a negative until a faint impression is obtained. A neutral solution of chloride of gold is then brushed over the paper, when the picture immediately appears, and is rapidly developed to a purple tint. It should then be very freely washed in several changes of water, fixed with a weak solution of iodide of potassium, and again thoroughly washed and dried. The action of the iodide of potassium is to convert any unaltered chloride of gold into a soluble double iodide of gold and potassium, thus rendering the picture permanent.



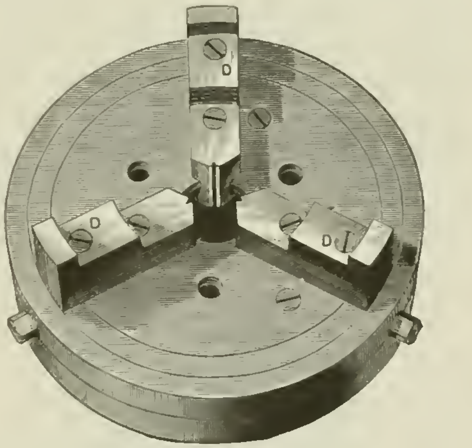


Fig. 1. Chucks. Fig. 2.

CHUCK.—An appendage to a lathe. Being screwed on to the nose of the mandrel, it is made to grasp the work to be turned. There are many varieties; the *eccentric*, *elliptic* or *oval*, and *geometric* chucks, with their combinations, are principally used in the arsenal.

The eccentric chuck is designed for changing the center of the work, and consists of two principal pieces; one attachable to the mandrel of the lathe, and the other adjustable, in a plane at right angles to the axis of motion, in a dovetail groove of the former piece. The sliding piece is moved by a set-screw.

The elliptic or oval chuck consists of three parts —the *chuck*, the *slider*, and the *eccentric* circle. The chuck is secured to and partakes of the circular motion of the mandrel. In front of the chuck is a dovetail groove for the reception of a slider, from the center of which projects a screw to which the work is attached. As the work turns round, it has a sliding motion across the center which generates an ellipse. The sliding motion is produced by an eccentric circle or ring of brass firmly fastened to the puppet of the lathe close to the collar in which the neck of the mandrel runs.

The geometric chuck has a radial slider to which the work is attached, and this is so governed as to give a combined circular motion and radial oscillation to the work relatively to the tool.

Fig. 1 represents the Pond independent four-jaw lathe-chuck. Each jaw is worked independently by its own screw, thus adapting it to hold any irregular-shaped piece, as well as round, square, or eccentric forms. The jaws are wrought-iron case-hardened; steel screws operating jaws are secured in the hub of the chuck to prevent irregular wear of same. This chuck has a solid hub so that it can be placed directly on the lathe spindle, thus bringing it nearer to the spindle-bearing and making less strain on the spindle; or the face-plates can be fitted to it, making the same chuck fit different lathes.

Fig. 2 represents the Skinner combination-chuck, which may be readily changed from *independent* to *universal*, and *vice versa*. To make the former change, it is only necessary to set all the jaws true on the line on face of the chuck, then slide the stud on the back of the chuck to the extreme end of slot and fasten it there by screwing down the nut. If the jaws do not come to center true, it is because they were not all set alike before throwing the rack into gear. To make the latter change, unscrew the nut and slide the stud to the extreme end of the slot and fasten it there by means of the nut.

Figs. 3 and 4 represent the Prouty planer-chucks. Fig. 3 shows the square base, and Fig. 4 shows a round swivel base. These chucks will hold regular or irregular shaped pieces, and can be quickly adjusted from their least to their greatest capacity. The round swivel-base chucks are accurately graduated, and the swivel is held in place by a single screw. See *Cushman Combination-chuck*, *Horton Lathe-chuck*, *Lathe*, *Sweetland Chuck*, and *Westcott Combination-chuck*.

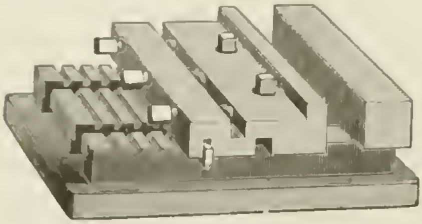


Fig. 3.

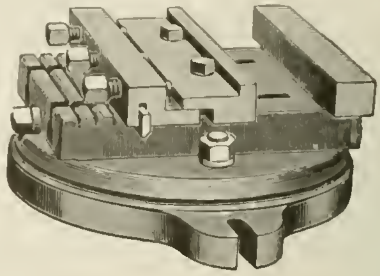
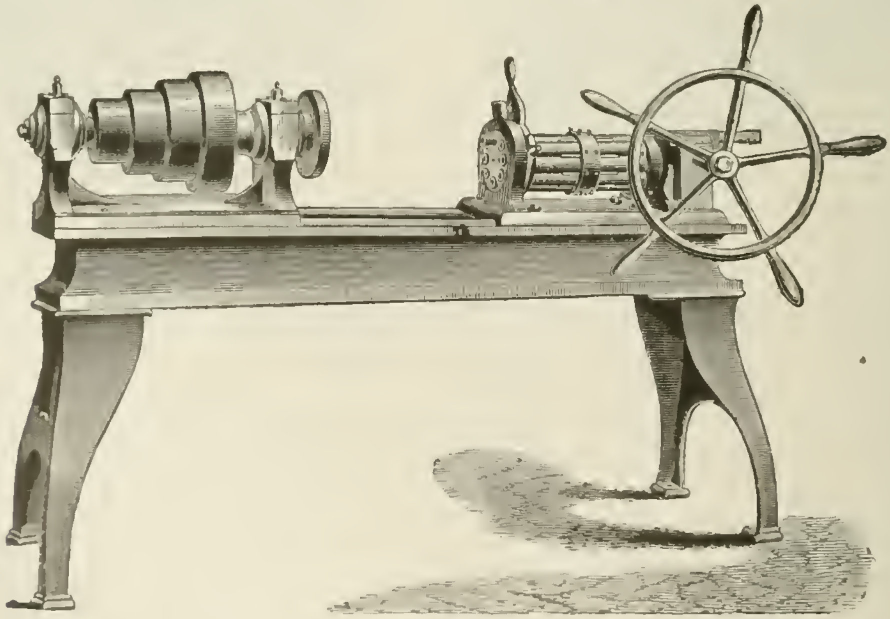


Fig. 4.

Planer-chucks.

CHUCKING-MACHINE.—A machine used in the armory for work on lock-parts and in chambering the barrels. The drawing shows the machine as made by the Pratt and Whitney Company, with horizontal revolving head. It is designed for a variety of work, such as drilling, facing, and tapping holes before removing the piece to be finished from the chuck or face-plate. The revolving head carries several spindles for the reception of tools. Each one is brought to the work successively by a single movement of a lever or handle, and is fed forward by a rack and pinion, operated by a convenient hand-wheel. The machine is rapid in its operation and very accurate in its results. The number of spindles in the head may be varied to suit the work to be done, and the length of the bed may be increased or diminished as desired. The machine is made in three sizes, 13, 18, and 24 inches swing. See *Drilling-machine*.



Chucking-machine.

CHUCKLER.—An Indian term, signifying a cobbler, or worker in leather. This class of men is employed in all the government establishments in India where leather-work is made up.

CIMBRI—KIMBRI.—A people who issued from the North of Germany in conjunction with the Teutons, and first came into hostile contact with the Romans in the Eastern Alps in 113 B.C. They were victorious in several great engagements, and were only prevented from devastating Italy by sustaining a terrible defeat from Marius, on the Raudii Campi, near Verona, or, according to others, near Vercelli, 101 B.C. Their infantry fought with their shields fastened together by long chains; their horsemen, of whom they had 15,000, were well armed with helmet, coat of mail, shield, and spear. Marius had so chosen his position that the sun and dust were in their faces, and yet they contested the victory most bravely with the Romans, who were 55,000 strong. When the battle was lost, the women, who remained in the camp formed of the wagons, killed themselves and their children. It is said that 140,000 Cimbri fell in the battle; the number of prisoners being given at 60,000. It is not till long afterwards, when the Romans themselves penetrated into Germany, that the name of the Cimbri again appears. Cæsar represents the Aduatici of Belgium as the descendants of the Cimbri and the Teutons. Tacitus speaks of a people bearing the name of Cimbri, few in number, but of great reputation, that sent ambassadors to Augustus. This people lived in the extreme North of Germany, on the borders of the ocean; according to Pliny and Ptolemy, at the extremity of the peninsula called from them the Cimbric Chersonese, now Jütland. The ethnology of the Cimbri is doubtful. Greek writers associated them groundlessly with the Cimmerians; Sallust calls them Gauls; Cæsar, Tacitus, and Plutarch looked upon them as Germans, and the opinion of their German origin has been adopted by most moderns. Yet H. Müller, in his *Marken des Vaterlands* (1837), has endeavored to show that they belonged to the Celtic race, and lived originally on the Northeast of the Belgæ, of kindred origin; and that their name is the same as that by which the Celts of Wales designate themselves to this day—*Cymri*.

CIMETER.—An Oriental cavalry-sword with a blade of great curvature. It is much used by the Persians and Turks, and is often written *Scimeter*.

CIMIER.—A heavy ornament which the ancient knights or chevaliers in France and in other countries were accustomed to wear upon their helmets; small figures were afterwards substituted in their stead.

CINCH—CINCHA.—A strong canvas girth used in packing. It is about 1 yard long by 11 inches wide. Two rectangular pieces of leather, 8 inches long by 5½ inches wide, are stitched on one end, one on either side; in one of these pieces of leather there is a slit through which a hard-wood hook is passed and firmly fastened with a leather thong. A ring, 3 inches in diameter, is securely stitched in the other end of the cincha. See *Hammer-cloth*, *Lash-rope*, and *Packing*.

CINCINNATI.—A Society or Order in the United States of North America established by the officers of the Revolutionary Army in 1783, "to perpetuate their friendship, and to raise a fund for relieving the widows and orphans of those who had fallen during the war." It was so named because it included patriots, headed by Washington, who in many instances had left rural affairs to serve their country. The badge of the society is a bald eagle suspended by a dark blue ribbon with white borders, symbolizing the union of France and America. On the breast of the eagle there is a figure of Cincinnatus receiving the Military Ensigns from the Senators, with the plow in the background; round the whole are the words, *Omnia reliquit servare rempublicam*. On the reverse, the same hero is represented crowned by fame with a wreath on which is inscribed *Virtutis præmium*, etc. As this distinction was made hereditary, it was attacked as opposed to republican equality. Franklin saw in it the germ of a future aristocracy, and at a meeting held in Philadelphia in 1784 several changes were made in the Constitution of the Society, and in several of the States it was quietly abolished. There are still, however, several State Societies, which hold a general meeting by delegates triennially.

CINQUAIN.—In ancient military history, an order of battle to draw up five battalions so that they might make three lines, that is, a van, main body, and reserve.

CINQUEFOIL.—A common bearing in Heraldry. It is usually depicted with the leaves issuing from a ball as a center-point. Cinquefoil, in architecture, is an ornamental foliation in five compartments, used in the tracery of windows, panelings, and the like. The cinquefoil is often represented in a circular form, the spaces between the points or cusps representing the five leaves. The cinquefoil of Heraldry and of architecture is not derived from any leaf of five leaflets, but, as its perfect regularity of form indicates, from the flower of the plant called cinquefoil, (*Potentilla*), or other similar flower of five petals or *leaves*. The cinquefoil thus closely resembles the rose, with which it would, indeed, be identified, but that a double and not a single rose is chosen for the purposes of Heraldry and decorative art.

CIPHER.—A preconcerted enigmatical system of communication. Much used in war when dispatches are liable to interception by the enemy,—both for written communication and for signaling. See *Cryptography*.

CIRCITORES.—A name generally applied, in the Roman armies, to the men who inspected the sentinels.

CIRCLE.—A plane figure bounded by a curved line, which returns into itself, called its *circumference*, and which is everywhere equally distant from a point within it called the *center* of the circle. The circumference is sometimes itself called the circle, but this is improper; *circle* is truly the name given to the space contained within the circumference. Any line drawn through the center and terminated by the circumference is a *diameter*. It is obvious that every diameter is bisected in the center. In co-ordinate geometry the circle ranks as a curve of the second order, and belongs to the class of the conic sections. It is got from the right cone by cutting the cone by a plane perpendicular to its axis. As an element in plane geometry, its properties are well known and investigated in all the text-books. Only a few of the leading properties will here be stated. 1. Of all plane figures, the circle has the greatest area within the same perimeter. 2. The circumference of a circle bears a certain constant ratio to its diameter. This constant ratio, which mathematicians usually denote by the Greek letter π, has been determined to be 3.14159 nearly, so that if the diameter of a circle is 1 foot, its circumference is 3.14159 feet. Archimedes, in his book *De Dimensione Circuli*, first gave a near value to the ratio between the circumference and the diameter, being that of 7 to 22. Various closer approximations in large numbers were afterwards made, as, for instance, the ratio of 1815 to 5702. Vieta, in 1579, showed that if the diameter of a circle be 1000, etc., then the circumference will be greater than 3141.5926535 and less than 3141.5926537. This approximation be made through ascertaining the perimeters of the inscribed and circumscribed polygons of 393,216 sides. By increasing the number of the sides of the polygons, their perimeters are brought more and more nearly into coincidence with the circumference of the circle. The approximation to the value of π has since been carried to 128 places of figures. It is now settled that π belongs to the class of quantities called *incommensurable*, i.e., it cannot be expressed by the ratio of any two whole numbers, however great. Though the value of π was at first approached by actually calculating the perimeter of a polygon of a great number of sides, this operose method was long ago superseded by modes of calculation of a more refined character, which, however, cannot here be explained. Suffice it to say, that various series were formed expressing its value; by taking more and more of the terms of which into account, a closer and closer approach to the value might be obtained. We subjoin one or two of the more curious.

$$\pi = 4\left(1 - \frac{1}{3} + \frac{1}{5} - \frac{1}{7} + \frac{1}{9} - \frac{1}{11} + \text{etc.}\right).$$

$$\pi = 8\left(\frac{1}{1.3} + \frac{1}{3.5} - \frac{1}{3.5.7} + \frac{1}{5.7.9} - \frac{1}{7.9.11} + \frac{1}{9.11.13} - \text{etc.}\right)$$

3. The area of a circle is equal to π multiplied by the square of the radius ($= \pi r^2$); or to the square of the diameter multiplied by $\frac{\pi}{4}$; i.e., by .7854. Euclid has proved this. 4. The circular measure of angles is in frequent use in gunnery, and depends directly on the proposition that angles at the center of a circle are proportional to the arcs on which they stand. Let POA be an angle at the center O of a circle, the radius of which is r, and let the length of the arc $AP = a$. Then $\frac{\text{angle POA}}{2 \text{ right angles}} = \frac{a}{\pi r}$; and $\angle \text{POA} = \frac{2 \text{ right angles}}{\pi} \cdot \frac{a}{r}$. Now, supposing a and r to be given, although the angle POA will be determined, yet its numerical value will not be settled unless we make some convention as to what angle we shall call unity. We are free to make any convention we please, and therefore choose such a one as will render the preceding equation the most simple. It is made most simple if we take $\frac{2 \text{ right angles}}{\pi} = 1$. We shall then have (denoting the numerical value of the angle POA by θ) $\theta = \frac{a}{r}$. The result of our convention is that the numerical value of two right angles is π, instead of 180° as in the method of angular measurement first alluded to; and the unit of angle, instead of being the ninetieth part of a right angle, is $\frac{2 \text{ right angles}}{\pi}$, or 57° 17′ 44″ 48‴ nearly. Making $\theta = 1$ in the equation $\theta = \frac{a}{r}$, we have a (or AP) $= r$ (or AO), which shows that in the circular measure the unit of angle is that angle which is subtended by an arc of length equal to radius. It is frequently a matter of indifference which mode of measuring angles is adopted; the circular measure, however, is generally the most advantageous, as being the briefest. It is easy to pass from this mode of measurement to the sexagesimal. If θ be the circular measure of an angle, the angle contains $\frac{\theta}{\pi} \cdot 180°$; conversely, if an angle contain $n°$, its circular measure is $\frac{n°}{180°} \cdot \pi$.

CIRCUIT-CLOSER.—An arrangement by which submarine mines are fired electrically by the vessel herself closing the circuit. Circuit-closers are of two classes, one being that in which the charge and the circuit-closer are in the same case, and the other is where the circuit-closer is in a separate case, but connected with the charge of the mine by an electrical cable. In both ways the conducting cable is electrically charged from the battery on shore up to the circuit-closer; when this latter is closed by contact with a hostile vessel, the current passes through the fuse in the charge and the mine is exploded. A great number of different forms of both classes have been invented, all of which are more or less complicated and require special description and study to understand.

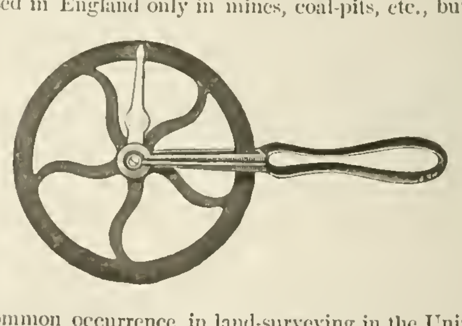
To render mines thus provided with circuit closers harmless to friendly vessels passing, it would be necessary only to detach the firing-battery—an operation usually performed by the operator simply removing a small plug. In this case the circuit-closer, if strongly made, may be struck time and again without injury. This power to resist heavy blows is essential to the efficiency of any form of circuit-closer, as, when in position in a channel through which there is much traffic, they are always liable to be struck with considerable force by blades of screws, floats of paddles, and other hard and sharp bodies. Another especial consideration is that the apparatus for closing the circuit shall not be set in action by agitation of the water, but only by impact with a floating body. The circuit-closer must furthermore have sufficient size to give the required amount of inertia. When the circuit-closer and charge are combined in the same case, this is assured; but when they are separate, it is effected by inclosing the mechanism in buoys made of wood or metal. The greater the size and weight of the circuit-closer, the greater will be the chances of the effective working of the apparatus. The destructive power of a mine decreases rapidly as the distance from it increases. The circuit-closer should not, therefore, be beyond the effective range of the mine. Forty to fifty feet should be the maximum distance for the heaviest charges. See *Mines*.

CIRCULAR CUTTER.—With the usual pyramidal form of the Rodman cutter it has been found difficult so to file the faces of the pyramid as to have two cutters identical in form and dimensions. The idea was therefore conceived of turning a beveled edge with a circular profile upon the perimeter of a steel disk, thus securing the perfect agreement of all cutters taken from that disk. The special advantage of the circular cutting or indenting edge is that it can be readily pressed into the indentation previously made in the copper disk while in the bore, upon its removal to the *dynamometer*, or testing-machine.

In the pyramidal cutter it is difficult to make the apex of the pyramid coincide with its former position in adjusting it to get the reading of the *estimator*. With the circular cutter no difficulty is experienced in adjusting its edge to the bottom of the indentation in the copper, when the operator wishes to make similar secondary cuts for determining the pressures. See *National Armory Circular Cutter*, *Rodman Cutter*, and *Rodman Testing-machine*.

CIRCULAR SAW.—This saw was introduced into England about 1790. General Bentham contrived the bench, slit, parallel guide, and sliding-bevel guide. He also invented circular saws made of segmental plates. In the modern and improved machine, the saw-arbor is carried in a swinging frame provided with an adjusting-screw for regulating its height, and a clamp-screw for holding it rigidly in any desired position. For simplicity of construction, ease of operation, and for rigidity in use this arrangement is superior to all others. To render the machines free from vibration, and to avoid the difficulties and disadvantages incidental to the use of short belts, excessive strain upon the bearings, difficulty of keeping belts at proper tension, etc., the counter-shafts are separate from the machines. In setting them the following rule should be observed: Set the saw midway between its highest and its lowest working positions, and then place the counter-shaft in a straight line with the arbor and the shaft on which the arbor-frame swings. See *Band-saw Machine*.

CIRCUMFERENTOR.—1. A surveying instrument used in England only in mines, coal-pits, etc., but of



common occurrence in land-surveying in the United States. Many of the old-fashioned surveyors yet use it, though it is disappearing as the theodolite becomes more and more commonly known.—2. An instrument employed to measure the tires of wheels. It consists of a wheel graduated on its periphery and axled in a holder. It has a circumference of known length, and is passed around the outside of the rim of a wheel to ascertain the length of the tire. The instrument having a perimeter, say, 2 feet in circumference, the zero is brought to a marked spot on the periphery of the wheel to be measured. The small wheel is then caused to travel around the larger, and indicates the length by making so many revolutions and such a fraction as the case may be. The instrument represented in the drawing and known as the Green River circumferentor is provided with an index-hand, which saves the trouble of marking the periphery.

CIRCUMVALLATION.—In fortification, a series of works surrounding a place when under siege,—not to serve offensively against the place, but to defend the siege-army from an attack from without. It usually consists of a chain of redoubts, either isolated or connected by a line of parapet. Such lines were much used in the sieges of the Ancient and Middle Ages; but in modern times they are not so necessary, because the use of artillery lessons the duration of a siege, and also because the besiegers have generally a corps of observation in the open field, ready to repel any force of the enemy about to succor the besieged. A remarkable example of circumvallation was that at Sebastopol, where, while a circuit cf batteries fired upon the town, an outer circuit of redoubts and lines kept off the Russians who were in the open field; but the necessity for this arose out of the smallness of the besieging force compared with that of the besieged. The narrow escape of the allies from utter overthrow at Inkermann showed the necessity for this external defense. See *Countervallation*.

CIS.—A Latin preposition, meaning "on this side," which is often prefixed to the names of rivers and mountains to form adjectives: Cisalpine, Cispadane, "on this side of the Alps," "of the Po." As most of these words are of Roman origin, Rome is considered the point of departure.

CITADEL.—A fort of four or five bastions, in or near a town. A citadel serves two purposes: it enables the garrison of a town to keep the inhabitants in subjection; and, in case of a siege, it forms a place of retreat for the defenders, and enables them to hold out after the rest of the town has been captured. A citadel must fully command the fortifications of the city, and have a large space round it clear of buildings. See *Castle* and *Fortification*.

CIVIC CROWN.—A crown considered among the Romans more honorable than any other reward. It was given for saving the life of a citizen in battle or assault. It was given to Cicero for his discovery of Catiline's Conspiracy, and to the Emperor Augustus. The Civic Crown was merely a wreath, at first of twigs of elm, then of beech, and lastly of oak. The one to whom it was given had the right to wear it always. When he appeared in public, if Senators were present, they rose to do him honor, and he was excused from all troublesome duties and services, with the same immunities for his father and his father's father.

CIVIERE.—A small hand-barrow which is carried by two men, and is much used by the artillery.

CIVIL AUTHORITY.—The relation between the military and civil authorities is set forth in the 59th Article of War. Respect for the civil authorities is the duty of all citizens, and especially of those in the military service. As the objects of the military service are of national interest, it is very desirable that kindly relations exist between soldiers and other citizens. A civil officer charged with the execution of process should receive proper facilities for its service on making known his character to the nearest Commanding Officer. See *Civil Service* and *Posse Comitatus*.

CIVIL DEPARTMENTS.—Branches of the British army under the War Office. They include the Control Department, Medical Department, Veterinary Department, Chaplain's Department, Education Department, and the Administration of Justice.

CIVIL EMPLOYES.—The Chief of each Military Bureau of the War Department, under the direction of the Secretary of War, regulates as far as practicable the employment of hired citizens required for the administrative service of his Department. He distributes the aggregate number which can be allowed, whether rated as clerks, teamsters, mechanics, or laborers, to the several Military Departments according to the number of troops therein, or according to the work to be done. Except for the Corps of Engineers, the grades of pay of clerks and other employés under the Staff Departments of the army whose salaries are not fixed by law are authorized as follows: There are six classes of clerkships, and each clerk or employé within the scope of this regulation is graded for pay in accordance therewith, viz.:

Class.	Pay per month.	Pay per annum.
First class	$83 33	$1,000
Second class	100 00	1,200
Third class	116 66	1,400
Fourth class	133 33	1,600
Fifth class	150 00	1,800
Sixth class	166 66	2,000

Any compensation greater than the above must receive the special approval and sanction of the Secretary of War; but nothing in this regulation is construed as prohibiting the payment of smaller salaries than the above for such lower grades of clerkships as the wants of the service may require. The selection of employés as clerks, etc., is left to the officer employing them, provided such selection has the approval of the Commander of the Division or Department in which the officer may be serving, and the approval of the Head of the Military Bureau, when serving at depots, arsenals, posts, and stations not under the immediate control of a Division or Department Commander. When practicable, persons hired in the military service are paid at the end of the calendar month, and when discharged. When a hired person is discharged and not paid, a certified statement of his personal services and of wages due is given. In computing the wages of laborers employed at a per-diem allowance, the actual number of days is to be ascertained and allowed. The day on which service begins and the day on which service ends should be counted in the computation of the wages earned. Laborers employed by the month and actually performing their first day's labor on the 31st day of any month are paid for that day. Citizens in the employ of any branch of the military service, except laborers, teamsters, and like classes of employés, when traveling under competent orders, or upon summons as witnesses before Military Courts, are entitled to transportation in kind; or, if no transportation be provided, they may charge the cost, actually paid by them, of travel fare by the usual conveyances, inclusive of transfer to and from depots, not exceeding fifty cents each, and of one berth in sleeping-cars, or on steamers where an extra charge is made therefor. Payment of parlor-car fare is prohibited. In addition to the above, the sum of four dollars per day west of the Mississippi River, and three dollars and a quarter east thereof, is allowed for each and every day unavoidably consumed in travel, or on duty under the order or summons; provided that where meals are included in the transportation, or fare, by steamers, no per diem shall be charged. Laborers, teamsters, and like classes of employés, traveling as above stated, are entitled to such actual and necessary expenses on account of transportation and subsistence as may be authorized by the Chief of the Bureau which makes payment of the account—except when the employé is in receipt of a ration from the United States, in which case, if it be impracticable to carry his rations with him, instead of expenses of subsistence, as above contemplated, he is paid commutation of rations at the usual rates. Actual expenses, as contemplated above, are payable as follows: To Paymasters' clerks and citizen witnesses before Military Courts, by the Pay Department; to citizens employed at arsenals and armories (cost of transportation included), from appropriations for the service of the Ordnance Department; to citizens employed on public works and fortifications (cost of transportation included), from the appropriation made specifically for the work; to Commissaries' clerks, Quartermasters' clerks and agents, and other citizens employed with the army, when traveling on public service, under orders of competent military authority, by the Quartermaster's Department.

CIVILIAN.—This term has three meanings, which are distinct, though intimately related. (1) In a popular sense it signifies a person whose pursuits are civil, i.e., neither military nor clerical. (2) As a law-term, it means either a person who is versed in the principles and rules in accordance with which civil rights may be freely, blamelessly, and successfully vindicated in society generally, or in the particular state in which he belongs. (3) One who has made a special study of these rules and principles as exhibited in the laws and government of Rome (the Roman civil law). The civil law of Rome exercised such influence upon the formation of the municipal systems of almost all the States of modern Europe that those who devoted themselves to its study were regarded as "civil" or municipal lawyers *par excellence*.

CIVIL SERVICE.—A general name for all the duties rendered to and paid for by the State, other than those relating to naval and military matters. Civil service in the United States was partially introduced in the Customs and some other offices in 1877 and the years following, but up to this time it has made no great progress. The general principles of the system are the same as in England, involving the separation of officials from all absorbing political partisanship, and, in general, the retention of capable and deserving Civil Officers through the successive changes of Administration. It involves also the promotion of worthy public servants as vacancies may occur. It lays the foundation for all this in conferring offices, not as reward for partisan services, but on strict competitive examination as to character, capacity, and education. By many it is pronounced both impracticable and undesirable; by others, a fine ideal not likely to be realized; and by others, an indispensable practical reform.

CIVIL WAR.—A war between two or more portions of a Country or State, each contending for the mastery of the whole, and each claiming to be the legitimate government. The term is also sometimes applied to war of rebellion, when the rebellious Provinces or portions of the State are contiguous to those containing the seat of government. See *Insurrection* and *Rebellion*.

CLAM.—In Heraldry, a term for an escalop or cockle shell, and supposed to indicate that the bearer has been a crusader, or has made long voyages by sea.

CLARIGATION.—In Roman antiquity, a ceremony which always preceded a formal declaration of war. The Chief of the Heralds went to the territory of the enemy, where, after some solemn prefatory indication, he, with a loud voice, intimated that he declared war against them for certain reasons specified, such as injury done to the Roman allies, or the like.

CLAY BREECH-LOADER.—An apparatus with which one side of the breech is enlarged to receive a screw-plug, a little more than twice the diameter of the bore. A hole in the plug forms, when the latter is unscrewed half a turn, a continuation of the bore, through which the charge is loaded. By screwing up the plug half a turn, the solid part of it covers the end of the bore and sets closely against it. The breech is thus opened by one movement, and the parts, though large, are simple; but the obvious defect is the great difficulty of applying a suitable gas-check.

CLAYES.—In sapping, hurdles to form blinds for working-parties. Reinforced with earth, they are substantially *gabions*, and as such are of a more permanent character. Frequently written *Clayonages*, and used to cover the timber-work of galleries.

CLAYMORE.—The Gaelic name for a kind of sword at one time much used, but not so well known at present. It had a double-edged blade, about 43 inches long by 2 inches broad; its handle was often 12 inches long, and its weight 6 or 7 pounds. This sword is now principally used by the officers and non-commissioned officers of Highland regiments.

CLEANING-MATERIALS.—Cleaning-materials for small-arms and accouterments are issued by the Ordnance Department to Company Commanders, at the rate of one box per company. On the under side of the cover of each box is pasted the following printed notice, viz.: "This box contains two quart cans of anti-corrosive and lubricating 'cosmoline' oil; one box holding 40 ounces scouring-material, marked 1, composed of 12 ounces paraffine, 18 ounces flour corundum, 6 ounces cosmoline oil, 4 ounces lamp-black, melted together; one box holding 16 ounces leather-polish, marked 2, composed of 13 ounces bayberry tallow, 3 ounces lamp-black, melted together; one box holding 40 ounces compressed whiting, marked 3; one chamois-skin; one wire scratch-brush. For removing rust and cleaning brass-work: Rub off a *very little* from box 1 on a cloth or on the end of the finger. For rust, use a soft stick. Finish with whiting for bright work, and oil for browned work. For polishing accouterments: 1. Rub off a little on the soft cloth from box; 2. Rub it well on the leather, and finish lightly with a soft cloth. Lubricating-oil: Apply the oil lightly with a rag.

"If the browning is rubbed off the barrel, dismount the barrel and remove the breech-block and parts of the extractor. Oil the bore of the barrel and stop up each end with a plug. Wash the outside of the barrel with hot soap-suds or lye of wood-ashes, to remove grease. Wash off with clean hot water. When dry, apply the browning-mixture, which is composed of 13 parts of water and 1 part of muriatic acid by measure, with a sponge or rag. Put the barrel aside to rust, in a damp and warm place, from three to four hours. Rub off the coat of rust so formed with the steel-wire scratch-brush; and repeat this three or four times. After each rusting pour on boiling water for several minutes to destroy the acid; use the scratch-brush as before, and finish with an oiled rag. In case the other parts get worn, a similar treatment should be employed. When convenient, the action of the browning-mixture can be promoted by laying the barrel in a closed box with a few cloths wet with hot water and spread so as not to touch the barrel; the box should be set in a warm place. The scratch-brush should be used lengthwise of the barrel. When the brush gets worn down, untwist the wire around it sufficiently to form a new head." The weight of the box filled, is 18 pounds. See *Care of Small-arms*.

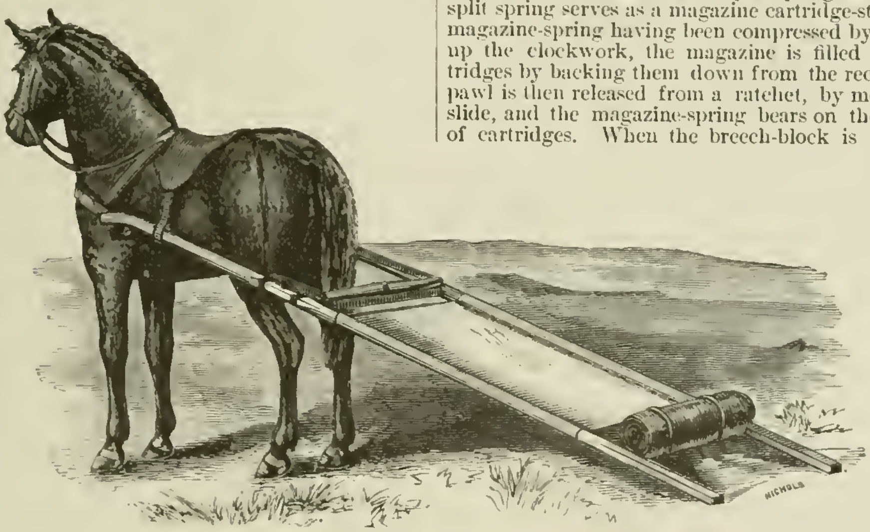
CLEARANCE.—In ordnance, the linear distance between the body of the projectile and the bore of the gun. The amount of the clearance before the projectile moves is the difference between the depth of the groove in the gun and the projection of the stud on the projectile; but when the projectile is in motion and centered in the bore, the clearance all round the projectile will be half the windage over the body.

CLEARANCE-ANGLE.—All guns fitted with a front sight on the top of the piece between the trunnions have what is called a *clearance-angle*. This may be defined as the angle of elevation obtained when the bottom of the notch of the rear sight and the top of the front sight and the notch on the muzzle are in line. If the rear sight is raised above this angle, the front sight falls below the line, joining the notch of the rear sight and the muzzle. The muzzle-notch must then be taken as the second point of sight.

CLEARING-SCREW.—In some fire-arms, a screw at right angles to the nipple, and affording a communication with the chamber.

CLEARY LITTER.—In 1875 Assistant Surgeon P. J. A. Cleary, U. S. Army, reported to the Surgeon General's Office his observations in the Indian Territory on the facility with which the Indians transported their sick and aged or infirm on litters dragged by ponies, and suggested that analogous conveyances might be utilized for the transport of wounded, in cavalry-scouts and in marches in difficult country where the use of wheeled vehicles was impracticable.

The drawing shows the modification of the Indian litter proposed. Each side-pole is jointed; by withdrawing a pin it comes apart, leaving the shafts in the harness, and the stretcher-frame disconnected. The length of the connected side-poles should be 17 feet, viz.: 5 feet occupied by the horse, 3 feet from rear of horse to first traverse or cross-piece of litter, 7 feet for bed of litter, 2 feet from bed of litter to the end. The advantages which the litter appears to possess are: 1. Simplicity of construction. 2. Facility of transportation, as it can be easily rolled up and carried either in a wagon or strapped to a horse. 3. It is drawn by *one* animal. 4. It requires but *one* man to work it. 5. The facility with which a patient can be brought into a hospital: by detaching it at the joint it is converted into a hand-litter on which the patient is readily conveyed to the ward of the hospital. 6. Its general adaptability for any kind of ground: in crossing cañons and deep gullies the litter proper could be easily detached, and a man at either end carry it as a hand-litter over any obstruction and again attach it; and finally, for any slight obstruction, the driver, without detaching it, could lift the rear end (the forward part being held in the harness) until the obstruction was passed. 7. Were it to be sent out with a cavalry command (with other supplies) and not required for actual use, it would occupy but a small space, and need not have even a horse sent with it—when, if required, the trooper's horse could be used to haul it. But one point in the harness needs special notice, viz., the straps across the horse's hips, which support the shafts; the object being to prevent the horse, in case he rears up, from jumping out of the shafts or kicking the patient. By these straps the horse *lifts* the litter every time he attempts to kick, and so cannot reach the patient. Straps attached to the side-poles, and passing under the arms and buttocks of the patient, counteract the tendency to slip due to the incline of the litter.



Cleary Litter.

CLEATS.—Small blocks of wood used commonly for securing movable articles which are likely, as at sea, to roll over or be displaced. In the artillery service they are used in different parts of gun-carriages for fixing tools, etc.

CLEMMONS MAGAZINE-GUN.—This gun is an adaptation of a magazine to the United States Springfield rifle. The alterations are as follows: The left side of the receiver is cut away nearly to the bottom of the well. The portion removed is replaced by a piece the interior of which is somewhat the shape of the half cartridge. This piece is open at the rear in order to receive cartridges from the magazine. A groove is cut in the left side of the butt-stock for the magazine-tube, and is covered by a brass plate. The magazine-spring and cartridge-follower are of the usual form. To the rear of the follower one end of a piece of tape is attached; the other end is connected with an ordinary clockwork by which the tape may be wound up, drawing back the follower and compressing the magazine-spring. On the inner surface of the piece attached to the receiver is a spring, pivoted at its front. This spring has a thumb-piece, which may be locked back by a spring-catch. The split spring serves as a magazine cartridge-stop. The magazine-spring having been compressed by winding up the clockwork, the magazine is filled with cartridges by backing them down from the receiver. A pawl is then released from a ratchet, by means of a slide, and the magazine-spring bears on the column of cartridges. When the breech-block is closed it strikes the thumb-piece, presses it back, and lets in a cartridge from the magazine. By pressing on this thumb-piece, the breech-block having been opened sufficiently to overcome the spring-catch, the cartridge is thrown into the receiver; it must then be pushed into the chamber in the usual manner.

As a magazine-gun, six motions are necessary to operate it, viz., cocked, opened, loaded (two motions), closed, fired. As a single-loader, the usual five motions are necessary to operate it. The gun carries five cartridges in the magazine, one opposite the receiver, and one in the chamber. See *Magazine-gun* and *Springfield Rifle*.

CLEPSYDRA.—An instrument for measuring time by the efflux of water through a small orifice. Two kinds have been in use—one wherein the fluid is simply allowed to escape through the orifice, the other in which the uniformity of the flow is secured by maintaining the fluid at a constant level in the instrument. The first would, like a sand-glass, give only an accurate measure of the time occupied in the escape of the whole fluid; of a shorter time it would be an inaccurate measure, as the pressure under which the escape takes place at the commencement is greater than at any instant thereafter, and constantly diminishes with the height of the fluid column. In the second, the flow must be nearly uniform; and if the water be received into a uniform graduated tube as it escapes, we have a tolerably good clock. The rate of the flow, however, is affected by temperature and barometric pressure. The clepsydra is supposed to have been used among the Chaldeans. The Romans employed it extensively. The invention of the pendulum has superseded it in modern ballistical investigations. The *electrical clock* is a clockwork machine, in which an electro-magnet, by means of an electric current regularly interrupted, is both the motor and the regulator. It is so constructed that at each oscillation of the pendulum the current is opened and closed, and thus an armature beats the seconds exactly. To illustrate the use of this contrivance, or the clepsydra, suppose that on the railroad from New York to San Francisco each station has an electric clock, and that from the New York station a conducting wire passes to all the clocks on the line as far as San Francisco. When the current passes in this wire, all the clocks will simultaneously indicate the same hour, the same minute, and the same second; for electricity travels with such prodigious velocity that it takes an inappreciable time to go from New York to San Francisco. See *Electric Clepsydra*.

CLICE.—An ancient Turkish saber, very long and curved. Now obsolete.

CLIDE.—A machine of war, used during the Middle Ages to throw rocks on besieging-parties.

CLIMAX GUN-CLEANER.—A gun-cleaning arrangement patented by the United States Cartridge Company, and said to be very effective in its work. It has a lower joint made of brass tubing, and forming a reservoir to contain the cleaning fluid. The *cleaner* is made of a solid piece of brass, and has a small hole drilled through it, which opens at one end into the reservoir, and terminates at a point between the rubbers. The *cleaner* is shouldered and has a brass washer on each side of each rubber, by which the rubbers can be expanded to produce any desired friction by turning the rod to the right after the *cleaner* is inserted in the barrel.

The operation is as follows: After putting the rod together, adjust the rubbers to fit the gun, then fill the reservoir with the liquid to be used, screw the *cleaner* in the reservoir, insert in the barrel, and the liquid will flow down into the chamber formed by the rubbers, and loosen the dirt. The rubbers will remove it. After cleaning, remove the *cleaner*, screw in a wiper, and wipe out the barrels. If it is wished to oil the gun, remove the rubbers, saturate the washers with oil, and put them on the cleaner in place of the rubbers.

CLINCHER-WORK.—A mode of uniting armor-plates in which the edges are lapped and secured by one row of rivets. It is distinguished from *carvel-build* in the respect that in the latter the edges of the plates are brought together and the joint covered by an interior *lap* or *welt*, to which the plates are secured by two rows of rivets, one to each plate.

CLINOMETER.—An instrument used in determining the slope of cuttings and embankments, the inclination of the trunnions, etc. It has a quadrant graduated to degrees and fixed at the end of a long bar which is laid adown the slope; an index turns upon the center of the quadrant, to which a spirit-level is attached. The level being set horizontally, the angle of the same will be indicated on the quadrant as the latter partakes of the motion of the rod.

The drawing shows the Abney level, an English modification of the "hand-level," combining with it an excellent clinometer. When the level is centered by setting the vernier-arm to zero on the divided arc, the bubble is seen through the eye end and the level ascertained precisely as with the Locke's level. And the main tube being square it can be applied to any surface, the inclination of which may be ascertained by bringing the level-bubble into its center, and reading off the angle to five minutes by the vernier and arc. The inner and shorter arc indicates the lines of different degrees of slope, the left-hand edge of the vernier being applied to the lines and the bubble brought into the center as usual. See *Hand-level*.

CLIP.—An instrument for lifting heavy shells. It is used in England with muzzle-loading guns from the 7-inch to the 12-inch.

CLIPEADUS.—The soldiers in ancient times who were armed with the Grecian buckler, which was large and round. By *clipeadus chlamyde* was understood combatants who, in place of the shield, wound their coats (*chlamyde*) around their left arms.

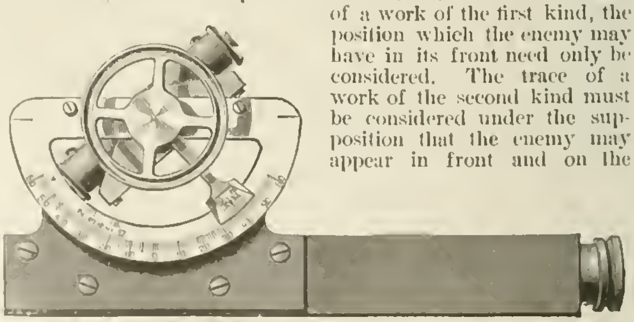
CLIPEUS.—A large shield worn by the ancient Greeks and Romans, which was originally of a circular form, made of wicker-work or wood covered with ox-hides several folds deep, and bound round the edge with metal.

CLITZ INTRENCHING-TOOL.—This proposed *intrenching-tool* consists of a sheet-steel blade, turned up on one edge and slightly curved cylindrically near the point. It is set in a light wooden handle split for its reception, and securely riveted together through the tang of the blade. This tool is intended for exclusive use as a mechanical implement, and frequently the straight edge is cut into saw-teeth. The soldier should never be separated from an intrenching-tool of some description. Many are the instances recorded where it was impossible to forward the *intrenching-tools* to the front until after the exigency for their use had passed, and the men were compelled to use tin plates, tin cans, fragments of canteens, knives, sticks, etc., in order to get temporary shelter from the enemy's most galling fire. See *Farrow Knife-trowel and Tent-peg* and *Trowel-bayonet*.

CLOSE.—A term in Heraldry. When the wings of a bird are down and close to the body it is described as *close*. The term is used only with reference to birds addicted to flight, such as the eagle, falcon, etc. Of dunghill cocks, and other domestic fowls, it is understood that their wings are in this position. Barnacles, and bits for horses, are said to be *close* when they are not to be understood as extended.

CLOSE COLUMN.—A column of troops in which the subdivisions are at less than full distance; that is, less than the length of one of the subdivisions.

CLOSED WORKS.—A field-work may have to fire on all sides of the position, over a limited portion of a circle, or in special directions only, according to the positions which may be occupied by the enemy's artillery. These different circumstances give rise to three kinds of field-works, viz.: 1. Field-works exposed to the artillery-fire of the enemy in one direction only, or in front; 2. Field-works exposed to artillery-fire of the enemy on the flanks as well as in front; 3. Field-works exposed to this fire upon all sides of the position. It is evident that in the trace of a work of the first kind, the position which the enemy may have in its front need only be considered. The trace of a work of the second kind must be considered under the supposition that the enemy may appear in front and on the flanks; that is, in a portion bounded by a part of a circle. The trace of a work of the third kind must be considered under the supposition that the enemy may appear on all sides of the work. Parapets are



Abney Level and Clinometer.

needed on all sides, in the works of the third kind, to shelter the men from the enemy's fire; and that they are only needed on the exposed sides, in works of the first and second kinds. The works of the first and second kinds may then be left open on the sides not exposed to artillery-fire, or they may be closed by some obstruction. The trace of a closed work may be of any form, either circular, square, quadrilateral, polygonal—regular or irregular—all salient angles, or some salient and some re-entering angles.

CLOSE ORDER.—In tactics, the space of about one-half pace between ranks. In the United States service, the distance between ranks, from back to breast, is *facing distance;* but on rough ground, and when marching in double time, it is increased to 32 inches; upon halting, the rear rank closes to facing distance. When the knapsack is worn, the distance between the ranks is increased by the depth of the knapsack. In alignments in double rank, the rear-rank men cast their eyes to the side of the guide with the front-rank men, and maintain the proper distance between the ranks.

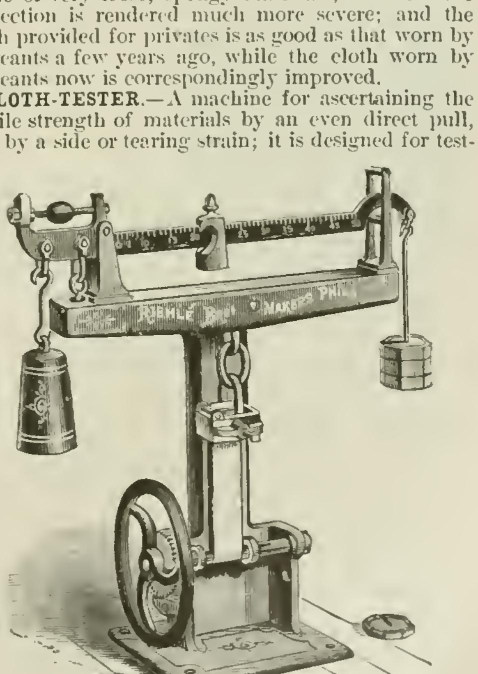
CLOTH.—A material formed by weaving or intertexture. In arsenals this material is much used, and is of various kinds—viz., book-muslin, buntin, canvas, doosootie (an Indian name), serge, vitry, waxed cloth, and silk. The cloths enumerated are made use of for the following purposes: Book-muslin, for the bottom of sieves, etc.; buntin, for colors; canvas, as shown under that head; doosootie, for capping carcasses, and it is also occasionally used for package and in making blowing-bags; serge, for service cartridge-bags; vitry, which is a fine kind of canvas, for making paulins and powder-cloths, occasionally for 13-inch blowing-bags, sponge-caps, and gun-aprons, also for saddle-wrappers; waxed cloth, for powder-barrels ($1\frac{1}{2}$ yard being required to pack a powder-barrel in), and for wrapping round elevating screws, fuses, etc.; silk, for exercising and saluting cartridges, though the use of this material is likely to be extended to service cartridges.

CLOTHING.—The President of the United States is authorized to prescribe the kind and quality of clothing to be issued annually to the troops of the United States. The manner of issuing and accounting for clothing is established by general regulations of the War Department. But whenever more than the authorized quantity is required, the value of the extra articles is deducted from the soldiers' pay; and, in like manner, the soldiers receive pay according to the annual estimated value for such authorized articles of uniform as shall not have been issued to them in each year. When a soldier is discharged, it is the duty of the Paymaster General to pay him for clothing not drawn. The Quartermaster's Department distributes to the army the clothing, camp and garrison equipage required for the use of the troops. Every Commander of a Company, Detachment, or Recruiting Station, or other officer receiving clothing, etc., renders quarterly returns of clothing according to prescribed forms to the Quartermaster General. All officers charged with the issue of clothing are required to make good any loss or damage, unles they can show to the satisfaction of the Secretary of War, by one or more depositions, that the deficiency was occasioned by unavoidable accident, or was lost in actual service, without any fault on their part; or, in case of damage, that it did not result from neglect. Purchasing clothing from a soldier is prohibited.

In England many changes and improvements have been recently made in the Clothing Department of the army. In the time of Henry VIII. the soldiers' dress was principally white, with green or russet for special corps. In Queen Elizabeth's reign a sum of 1*s*. 8*d*. was allowed weekly for each soldier's clothing. The uniform then consisted of a cassock of Kentish broadcloth, a canvas doublet, kersey stockings, trousers of kersey broadcloth, neat's-leather shoes, and Holland shirt. In 1678 an infantry soldier's dress was valued at £2 13*s*., and a dragoon's as high as £6 16*s*. At one time Lords-lieutenant attended to the clothing of the troops, each in his own County; but the duty was afterwards transferred to the State. Captains of companies clothed the men, stopped the money out of the pay, and made a profit on the transaction. The privilege afterwards passed to the Colonels of regiments. The sum provided by the State every year was for the "effective" strength of the regiment; and any vacancies put an additional sum into the pockets of the Colonel. From 1746 to 1855 soldiers' pay was debited with "off-reckonings," as a means of paying for the clothes supplied to the men. Under this system the Colonel received from the State so much money annually for clothing his regiment, and then contracted with wholesale tailors for a supply on the lowest terms. In 1854, just before a change was made in the system, the Colonel's profit, on the clothing for a private in the Line, was 15*s*. 3*d*. per man.

The disasters during the early months of the Crimean War having created a national demand for reforms in military matters, a change in the mode of army clothing was one of the results. By a Royal Warrant, dated June 21, 1855, the Colonels of regiments were awarded certain annual sums of money in lieu of off-reckonings. These sums varied from £1200 to £500, and were to be given in addition to the pay. From that date all the troops have been clothed by the Government, the off-reckonings being calculated nearly as before, but paid by the country to the Colonels. When the War Office was remodeled about the same time, a Clothing Department was added to it; and it was now found that the clothing for a full regiment of 1091 non-commissioned officers and rank and file, in the Line, cost about £2500 per annum. The clothing is now contracted for more openly than under the former system; and better materials are hence obtained without any increase in cost. The Government has a factory on its own account, but a large part of the supply is obtained by contract. Formerly soldiers' coats were too often made of very loose, spongy materials; but now the inspection is rendered much more severe; and the cloth provided for privates is as good as that worn by sergeants a few years ago, while the cloth worn by sergeants now is correspondingly improved.

CLOTH-TESTER.—A machine for ascertaining the tensile strength of materials by an even direct pull, also by a side or tearing strain; it is designed for test-



ing materials for tentage, blankets, clothing, etc. The drawing shows such a contrivance with the following dimensions: Extreme height, 2 feet 5 inches; extreme length, 2 feet 3 inches; extreme width, 12 inches; weight, 65 pounds. Adaptation: Tensile specimens 12 inches long by 3 inches wide or less, capacity 500 pounds. This machine is a recent invention, and is a great assistance to Quartermasters and others who purchase cotton and woolen materials and are responsible for their quality. The machine readily compares articles of clothing with that of any standard grade. See *Testing-machine.*

CLOUT.—An iron shield or plate placed on a piece of timber in a carriage—as on an axletree—to take the rubbing and keep the wood from being worn.

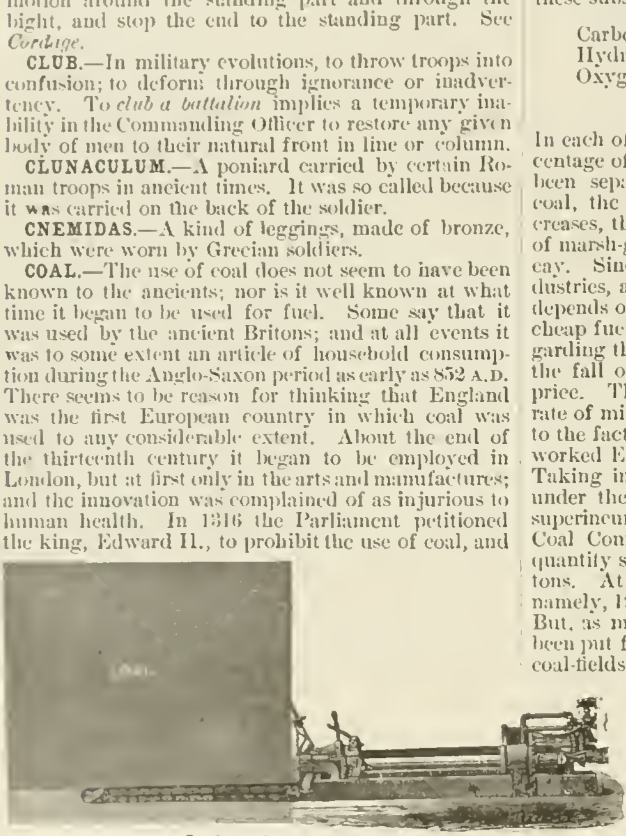
CLOVE-HITCH.—Two half-hitches. To make this hitch give the rope a turn around the object, pass the end of the rope round its standing part, and then through the bight. To make a *clove-hitch*, repeat the motion around the standing part and through the bight, and stop the end to the standing part. See *Cordage.*

CLUB.—In military evolutions, to throw troops into confusion; to deform through ignorance or inadvertency. To *club a battalion* implies a temporary inability in the Commanding Officer to restore any given body of men to their natural front in line or column.

CLUNACULUM.—A poniard carried by certain Roman troops in ancient times. It was so called because it was carried on the back of the soldier.

CNEMIDAS.—A kind of leggings, made of bronze, which were worn by Grecian soldiers.

COAL.—The use of coal does not seem to have been known to the ancients; nor is it well known at what time it began to be used for fuel. Some say that it was used by the ancient Britons; and at all events it was to some extent an article of household consumption during the Anglo-Saxon period as early as 852 A.D. There seems to be reason for thinking that England was the first European country in which coal was used to any considerable extent. About the end of the thirteenth century it began to be employed in London, but at first only in the arts and manufactures; and the innovation was complained of as injurious to human health. In 1316 the Parliament petitioned the king, Edward II., to prohibit the use of coal, and



Lechner Coal-cutting Machine.

a proclamation was accordingly issued against it; but owing to the high price of wood its use soon became general in London. It was for a long time known there as *sea-coal*, because imported by sea. Several theories as to the mode of the origin of coal have been put forth from time to time. The one now generally believed in is that the rank and luxuriant vegetation which prevailed during the carboniferous age grew and decayed upon land but slightly raised above the sea; that by slow subsidence this thick layer of vegetable matter sunk below the water, and became gradually covered with sand, mud, and other mineral sediment; that then, by some slight upheaval of the sea-bottom or other process, a land-surface was once more formed, and covered with a dense mass of plants, which in course of time decayed, sank, and became overlaid with silt and sand as before. At length thick masses of stratified matter would accumulate, producing great pressure, and this, acting along with chemical changes, would gradually mineralize the vegetable layers into coal. Some experiments made by Dr. Lindley, a few years ago, showed that of a large number of plants kept immersed in water for two years, the ferns, lycopodiums, and pines were those which had the greatest powers of resisting decay, and coal appears to be mainly composed of the substance of the ancient representatives of these three orders of plants. The interesting fact has also been lately proved, by Huxley, Morris, Carruthers, and others, that in many instances the bituminous matter in coal is almost wholly formed of the spore-cases and spores of plants allied to our club-mosses and ferns.

As will be seen from the following table, wood, peat, lignite or brown coal, and true coal indicate by their composition the changes which vegetable matter undergoes by decay and pressure; and a table in which a considerable number of examples of each substance could be given would show how gradually these substances pass into each other:

	Wood.	Peat.	Lignite.	Coal.
Carbon	50.0	60.0	65.7	82.6
Hydrogen	6.2	6.5	5.3	5.6
Oxygen	43.8	33.5	29.0	11.8
	100.0	100.0	100.0	100.0

In each of these bodies there is usually a small percentage of nitrogen, which in the above table has not been separated. In passing from wood or peat to coal, the proportion of oxygen and hydrogen decreases, these substances being given off in the form of marsh-gas and carbonic acid in the process of decay. Since the prosperity of our great national industries, as well as much of our domestic comfort, depends on the continuance of an abundant supply of cheap fuel, much anxiety has arisen of late years regarding the future supply and price of coal. Since the fall of 1872 a great rise has taken place in its price. This is partly owing to the unusually high rate of miners' wages which has prevailed, and partly to the fact that some of the richest and most easily worked English coal-seams are becoming exhausted. Taking into account the coal which probably exists under the permian, new red sandstone, and other superincumbent strata in the United Kingdom, the Coal Commissioners increase their estimate of the quantity still available for use to 146,480 millions of tons. At the present rate of annual production—namely, 123,500,000 tons—this would last 1186 years. But, as may be supposed, the estimates which have been put forth regarding the probable duration of our coal-fields are very various, some authorities asserting that, owing to increase in population and the increasing consumption of coal in factories, about 100 years will suffice to exhaust them. Between this and the other extreme of about 1000 years, formed on the assumption that the population of the country will but slightly increase, there are innumerable conjectures and estimates.

The annual production of coal throughout the world has been roughly estimated at 260,000,000 tons, including about 17,000,000 tons of lignite and coal from the formations newer than the coal-measures of Europe. Nearly one half of this total was raised in Great Britain. Excluding lignite the figures are as follows:

	Tons
Great Britain	125,000,000
United States	48,000,000
Germany	35,000,000
France	17,500,000
Belgium	17,000,000
Austria	4,700,000
New South Wales	1,300,000
Russia	1,000,000
Spain	750,000
India	700,000
Other Europe	125,000
British North America	750,000
Chili	200,000
Australia	50,000

In America the first coal discovered was by Father

Hennepin, near what is now Ottawa, Ill. The first mining of coal was in 1813, when five boat-loads of flinty coal were floated down the Lehigh River and sold in Philadelphia for $21 per ton. The fuel of the period was almost entirely of wood, Liverpool coal being a rare luxury. As late as 1821 only 22,122 tons of coal (Liverpool) were imported into the United States. The first regular shipments of coal from the Pennsylvania mines begin in 1820. The coal industry of Pennsylvania has reached enormous proportions, the annual product being valued at over $50,000,000. Besides more than 20,000,000 tons of anthracite coal there are mined in Pennsylvania near 10,000,000 tons of bituminous coal annually. Of bituminous coal the States of Ohio and Illinois produce the next most extensive yield, each about 3,000,000 tons annually. In 1870 there were 1566 collieries in the United States, employing 92,454 hands, and invested capital to the amount of $110,000,000. In 1820 the total coal product of Pennsylvania was less than 2000 tons. It is now more than 30,000,000 tons per annum.

One of the most successful applications of compressed-air engines has been in the working of coal-cutting machines. Of these machines, Firth's in England, Gladhill's in Scotland, and Brown's in America have been in practical operation for several years; but they can as yet only be economically worked under exceptionally favorable circumstances. A very satisfactory form of the coal-cutting machine has an engine with a reciprocating piston driving a massive steel pick, in any desired direction, and at a very material saving in hewing, or *kirving*. The motive power of the engine is highly compressed air, condensed by the steam-engine at the mouth of the pit, and this elastic air is conveyed by slender pipes down the shaft and along the mine to the breast where the coal is being worked. The compressed air is pumped by the steam-engine into a receiver at the pit-head during its otherwise idle hours, or by its surplus power when drawing up the coal, or pumping out the water from the mine, and is condensed to a tension of forty or fifty pounds to the square inch. It is conducted in metallic pipes 4½ inches in diameter, down to the bottom of the shaft, and thence in pipes of a smaller diameter to the workings, tubes of 1 or 1½ inch caliber bringing it to the cylinder of the machine. This compressed air, when set free at each alternating stroke of the piston, imparts to the adjacent portions of the mine a pure dry, cool atmosphere, from a well-known law of all air and gases, that when compressed they develop heat, and when expanded under a relaxation of pressure they are relatively cool.

The drawing represents the Lechner coal-cutting machine, much used in America. The under-cutting by this machine is done by a revolving horizonal cutter-bar of from three to four feet in length, driven into the coal by two small engines attached to a stationary frame. The cutter-bar is revolved by two endless steel chains, and when the desired depth of cut is reached, is withdrawn almost instantly by the smaller reversed screw. The cuttings are removed by means of scraper-chains, as seen in the drawing. The machine is placed in front of the coal at one side of the room, on the floor of the mine; the cutter-bar is driven into the coal five feet, and by the reversed screw mentioned above is withdrawn, when the machine is moved over the length of the cutter-bar used, and another cut is made, withdrawn again, and set over as before, and so on continually, until the entire room is under-cut, when the machine is placed on a car for the purpose, and run into another room. The time required to make the cut, 3 to 4 feet wide, 4 inches high, and 5 feet deep, is from 6 to 8 minutes; withdrawing and setting over, 2 minutes. Time consumed by each cut, 10 minutes. See *Anthracite* and *Coke*.

COAST-BATTERIES.—Batteries erected along a coast to protect the entrances of harbors and ports. They are armed with artillery of the largest caliber to oppose the landing of an enemy. The nature of ordnance for coast-defenses in England was in 1860 recommended to be as follows: the 10-inch gun of 86 cwt.; the 68-pdr. of 95 cwt.; the 8-inch gun of 65 cwt.; the 32-pdr. of 56 cwt.; the 13-inch sea-service mortar. Since the introduction of rifled artillery and armor-plated ships, the old smooth-bore guns, which formerly were used for coast-defense, have been superseded by the heavier rifled ordnance of the present day. See *Ordnance*.

COAST-GUARD LIGHT.—A light used for signals, and which burns about five minutes. It has superseded the coast-guard port-fire, and its composition consists of saltpeter, 7 pounds; sulphur, 1 pound 12 ounces; red orpiment, 8 ounces. The top of the composition is primed with mealed powder, and the flash blows off the cap. It is ignited by placing a G.S. primer in the hole in the head of the apparatus, and a sharp blow with a pin projecting from it sets the light on fire. The primer is made on a similar plan to the friction-tube; the pin is roughed and coated with friction-tube composition.

COATED PROJECTILES.—The surfaces of projectiles to which the lead covering is attached is smooth, and the cannelures formerly in use to secure strength in the attachment of the lead are now omitted. The lead coating is held on by tinning, and at first cast on quite thick, but afterwards turned off in a lathe, leaving the usual projecting bands. The iron surface of the projectile is cast smooth, and then dipped in a solution of sal-ammoniac; after this it is immersed in a bath of melted zinc, and at the same time revolved on its long axis by means of an iron rod inserted in the fuse-hole. During this revolution, which is done by one workman, another presses a mass of sal-ammoniac, fastened to the end of an iron rod, on the surface of the projectile. After a sufficient amount of zinc is made in this way to adhere to the surface, the projectile is placed in an iron mold and the lead coating cast on it. The lead coat occasionally becomes detached in spots, where the lead has risen up into blisters from the formation of gas underneath it, occasioned by voltaic action between the different metals. Such blisters are generally very small, and may be pricked and then hammered down, without affecting the fitness of the projectile for service. If left to develop themselves, they have been known to attain a large size.

The surface of the coating usually has raised bands or welts to take the rifling of the piece. In the German service the front band, *a*, as shown in Fig. 1, is

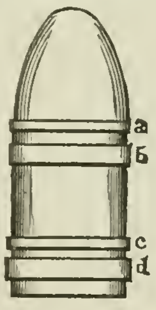


Fig. 1.

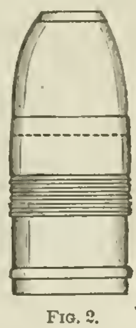


Fig. 2.

smaller in diameter than the others. Next larger is the band *b*, then comes the band *c*, and largest in diameter of all is the rear band, *d*. The lead coating is preserved from injury by two grommets, which are nearly severed to facilitate removal, and the projectiles are stored in racks fitted in the shell room. Sometimes the body of the projectile is not strictly cylindrical, but rather smaller at the base, the lead coating bringing the finished body into a cylinder. This form is considered good for penetration, but any lead coating must considerably retard the projectile in endeavoring to force its way through armor.

This lead covering causes a great waste of power, as it is the iron part alone, of the shell, that can do work against the iron plates, and consequently a considerable force is expended in projecting a part of the projectile which is useless for the work which has to be performed. A bearing of lead upon iron is, mechanically speaking, one of the worst conceivable, and particularly under high pressures and velocities. The coefficient of friction for a bearing of lead upon cast-iron, wrought iron, or steel is greater than for that of almost any other two metals; and it increases very decidedly in some contacts with an increase of temperature.

The projectiles of the 3-inch steel boat-gun are fitted with a copper rotation-belt over the center of gravity, as shown in Fig. 2. The belt has a length of bearing of 2 inches and a taper towards the front; it is grooved around the rear part. About .3 of an inch from the base is fitted a steadying-ring, .25 of an inch broad, and semicircular in section. On the exterior of the cylinder of the projectile, and about over its center of gravity, a broad groove or recess is cut .02 of an inch in depth, and as long as the rotation-belt (which it is to receive). At .4 of an inch from the base of the projectile another groove is cut, of similar depth and ¼ inch wide; this is to receive the guide-ring. A cold-chisel is then used to nick the bottoms of these grooves all around at intervals of about ½ an inch; the direction of the chisel-marks being lengthwise of the projectile, and their depth about two or three hundredths of an inch.

Cylindrical rings of copper are cast in sand-molds, and of length suitable for making rotation-belts and guide-rings. The interior diameter of these rings is very slightly greater than that of the cylindrical part of the projectile. The thickness of the metal is .15 of an inch. The rings are then slipped over the projectiles, and squeezed (or permanently compressed) by a screw press into the grooves prepared for them. This operation not only fills the grooves completely and makes the rings hug the body of the projectile, but also forces the copper slightly into the marks left by the cold-chisel at the bottom of the grooves; thus powerfully assisting to prevent any possibility of the belt slipping circumferentially upon the projectile. The projectiles, with their rough belts and rings on them, are then centered in the lathe, and the bearings are carefully turned down to the diameters and profiles given on the drawings. See *Compression-projectiles*, *Lead-coating Process*, and *Projectiles*.

COAT OF ARMS.—In the military trappings of the Middle Ages, the coat of arms held the place of the *paludamentum* of the ancient Roman Captains. It was a coat worn by Princes and Great Barons over their armor, and descended to the knee. It was made of cloth of gold or silver, of fur or of velvet, and bore armorial insignia. The "coat of arms," as understood by Heraldry in the present day, is nothing more than a relic of the ancient armorial insignia, divested of the coat on which it used to be embroidered.

COAT OF MAIL.—In the armor of the Middle Ages, a suit made of metal scales or rings, linked one within another. See *Armor*.

COCKADE.—According to Wedgwood, this word signified originally a cocked hat, or a hat with the broad flap looped up on one side, and was then applied to the knot of ribbon with which the loop was ornamented. Another view is that it is derived from *coquart*, a beau, or one fond of gay trappings. The word is now, however, restricted to signify an appendage to the head-dress worn as a military or naval distinction. Badges of distinction were early had recourse to in party and civil warfare. A sprig of broom (*planta genista*) was the badge of the House of Plantagenet. In England, during the wars between the Houses of York and Lancaster, the adherents of the former party were distinguished by a white and the latter by a red rose worn in the cap. The party organized at the Court of Charles IX. of France to perpetrate the massacre of St. Bartholomew recognized one another by a paper cross. The faction of the *Fronde*, opposed to Cardinal Mazarin, wore stalks of corn for the same purpose; and certain military bands were called *lances vertes*, from decorating their lances with green twigs. The use of cockades, as marks of distinction in campaigns and battles, became very general about the beginning of the eighteenth century. Eugene and Marlborough gave the Germans, English, and Dutch, composing their army, a tuft of corn or grass as their signal or cockade. The use of the cockade began to be more fixed in the War of Succession. White being the color of France, and red of Spain, the two colors were united in the cockade of the combined army. At last, in 1767, an authoritative regulation determined that every French soldier should wear a cockade of white stuff; and in 1782 cockades were prohibited to all but soldiers. From this time till the Revolution the cockade was an exclusively military badge; and, both in France and England, "to mount the cockade" was synonymous with becoming a soldier. But in the enthusiasm of 1789, the citizens of France generally assumed the tricolored ribbon as the badge of nationality and patriotism, which was soon also given to the army. The three colors were blue, white, and red: white had long been the color of France and its kings; the blue is understood to have come from the banner of St. Martin, and the red from the orillamme. Long before the Revolution, the three colors were used in combination: they were given by Henry IV. to the Dutch, when they desired him to confer on them the national colors of his Country, and have ever since been borne by the Dutch Republic and Kingdom of the Netherlands. At the Restoration, the white cockade of the Monarchy again took its place, but had to give way once more to the tricolor, which continues to be the cockade of the French army. Black, with some distinction, enters into the cockades of the German nations. The Austrian is black and yellow; and the Prussian was black and white, abandoned for the black, yellow, and white of the German Empire. After the German War of Liberation in 1813, a national cockade of black, red, and gold came into general use, and was afterwards assumed by the military and by officials. The wearing of these German cockades was prohibited in 1832 by a Resolution of the German Diet; but in 1848 they were again introduced, not only by patriots as a badge of German union, but into the armies. The national colors of Belgium are black, yellow, and red. Cockades of these colors were worn by almost the whole population of Brussels on occasion of the Constitutional Festival, July 21, 1860. Cockades of green, white, and red are worn in Italy. The Continental cockade is generally in the shape of a flat disk, sometimes of metal, sometimes of silk or other stuff, with the colors disposed concentrically.

COCK-FEATHER.—In archery, the feather which stood up in the arrow, when it was correctly placed upon the string, perpendicularly upon the cock or notch.

CODE.—1. A body of laws established by the Legislative Authority of the State, and designed to regulate completely, so far as a statute may, the subjects to which it relates. The earliest and most complete Code of the American States is that of Louisiana, finished in 1824, the work of Edward Livingston, a member of the celebrated family of that name in New York, and was based on the Code Napoleonenne. It has 3522 Articles in one series, but comprises three books—(1) of Persons; (2) of Things, and the Modification of Property; (3) of the Different Modes of Acquiring Property. A Code was completed in Massachusetts in 1835, and it was revised twenty years later. New York's first Code formed the Revised Statutes of 1830. There have been various more or less complete revisions, and there is the whole or a part of a further revision now before the Legislature. All except the latest new States have compilations of the codified editions of their laws. David Dudley Field of New York has been active and eminent in the work of codification.—2. A list of signal-symbols.

COEHORN MORTAR.—The Coehorn mortar, which takes its name from its inventor, General Coehorn, is a very small bronze mortar, designed to throw a 24-pounder shell to distances not exceeding 1200 yards. Its weight is 164 lbs., its maximum charge ½ lb. of powder, and it is mounted on a wooden block furnished with handles, so that two men can easily carry it from one part of a work to another. In the late war this piece was much used in the field against troops covered by rifle-pits. At Fort Wagner, General Gillmore says that it followed close on the heels of the sappers and did good service against the enemy who were not sheltered against vertical fire. If fired with friction-primers, this mortar should be provided with a shield of sheet-iron so placed as to prevent the fragments of the primers from flying among the gunners.

To serve the piece, four men are necessary: one chief of detachment, one gunner, and two cannoneers. The implements and equipments are carried in a basket, which is put near and in rear of the mortar. They are as follows: primer-pouch, containing priming-wire, primers, and lanyard; gunner's pouch, containing gunner's level and a pair of small pincers; one quadrant, one sponge, one plummet, and one mallet. A small wedge is used as a quoin. The mortar should have a permanent line of metal marked on it; otherwise this must be marked as for the 10-inch siege-mortar. The shells should be strapped with tin, and be provided with cord handle. They, together with the powder and fuses, are kept in the service-magazine. The service of the piece is analogous to that for the 10-inch siege-mortar.

When Coehorn mortars accompany troops in campaign, they may be carried on ordinary field-caissons; each caisson carrying one mortar, together with sixty rounds of ammunition. The mortar is carried on the caisson-body, the front chest being removed for this purpose. The piece is securely lashed with ropes through the handles. The remaining ammunition-chests are arranged to carry thirty shells each. The powder is in cans, and a set of measures (from one to six ounces) should be provided. The shells should be charged and the fuse-plugs driven, ready for the insertion of the fuses. A caisson with chest similarly arranged should accompany each piece. The mortars may also be carried in ordinary army transportation-wagons. Each wagon will carry one Coehorn and its equipments (weighing 311 pounds), and sixteen boxes, each containing eight shells and weighing 168 pounds, or 2688 pounds, making a total of 2999 pounds: a fair load, on good roads, for four horses or six mules. See *Mortar*.

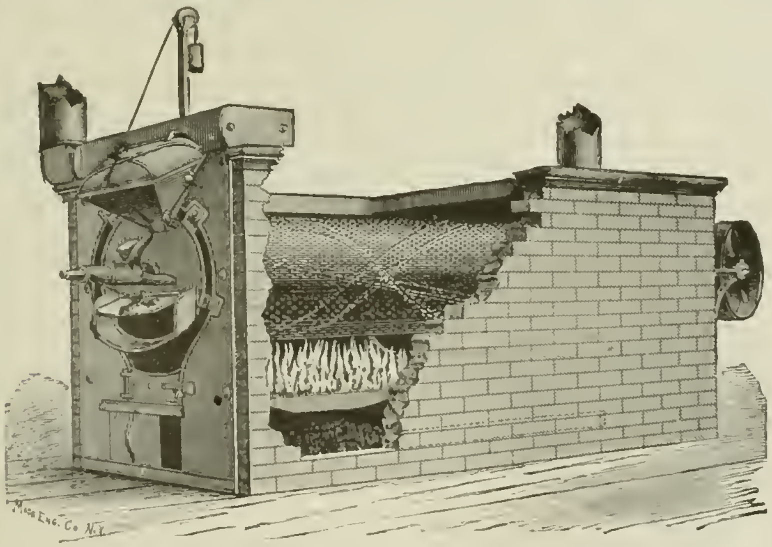
COEHORN SYSTEM OF FORTIFICATION.—Coehorn's method of attack was the very opposite of that of his contemporary and rival; whilst Vauban advanced surely and slowly, sparing life and intrenching every step, Coehorn sacrificed everything to time, and trusted to an overwhelming fire of artillery and audacious assaults. At Bonn, in 1703, besides a large park of heavy ordnance, he employed 500 small mortars to throw grenades. Coehorn has been placed at the head of the modern Dutch school.

COFFEE.—This most important article of the soldier's ration owes its exhilarating and refreshing properties to the presence of three substances: 1. *Caffeine*, which occurs in the roasted bean to the extent of ¾ to 1 per cent; 2. A *volatile oil*, which is not present in the raw bean, but is developed during the process of roasting to the extent of only one part in about 50,000 of the roasted coffee; 3. Astringent acids, resembling tannic acid, but called caffeo-tannic and caffeic acids. The average composition of unroasted coffee is as follows:

Caffeine	0.8
Legumin (vegetable caseine)	13.0
Gum and sugar	15.5
Caffeo-tannic and caffeic acids	5.0
Fat and volatile oil	13.0
Woody fiber	34.0
Ash	6.7
Water	12.0
	100.0

When the beans are roasted till they assume a reddish-brown color, they lose 15 per cent by weight and gain 30 per cent in bulk; when further roasted till they become chestnut-brown, they have lost 20 per cent by weight and increased 50 per cent in bulk; whilst if the roasting is continued till the beans become dark brown, they lose 25 per cent in weight and acquire 50 per cent in bulk. The beans should never be darker than a light brown color, which is quite sufficient to bring out the excellent aroma and other qualities of the coffee; and when the roasting is carried further, more or less charring is the result, and a disagreeable burned smell is produced, which tends to overcome the natural pleasant aroma.

Frequently on the march and in camp there are no-



Abele Coffee-roasting Machine.

facilities for properly roasting coffee, and experience has shown that it is well for troops in the field to be supplied with coffee previously roasted at the depots. The drawing shows the Abele roasting-machine, employed at most military posts and supply-depots. This machine has every advantage of the old-style sliding cylinder, together with numerous important improvements. Charged and discharged, both at the same end in front, it saves 50 per cent of space; with time and labor to the tender, and maintains perfect ventilation throughout, to oxidize the coffee by inhaling currents of air; with outlets for the exhalation of gas and steam from within. When desired it may have forced circulation, as by a fan (and water admitted from the hydrant or from a tank above); while the coffee is easily examined at every stage in oxidation, without interfering with the work or stopping the action of the machine. The important points accomplished in the machine are:

1. To keep the material in uniform motion, to and fro, by means of ingeniously constructed shovels and stirrers that will expose every particle to exactly the same degree of heat.

2. To draw in through openings in front a current of oxidizing air to surround the coffee during that chemical change; making up in part, by the oxygen absorbed, for any subsequent loss and neutralizing the gases, to be blown off by the same currents of air towards the rear of the furnace into the smoke-stack above.

3. To provide for the immediate escape of steam from within, by means of an exhaling ventilator, located over the cylinder in front.

The usual methods of preparing coffee are, first, by *filtration;* second, by *infusion;* third, by *boiling.* Filtration gives often, but not always, a good cup of coffee. When the pouring the boiling water over the ground coffee is done slowly, the drops in passing come in contact with too much air, whose oxygen works a change in the aromatic particles, and often destroys them entirely. The extraction, moreover, is incomplete. Infusion is accomplished by making the water boil, and then putting in the ground coffee; the vessel being immediately taken off the fire and allowed to stand quietly for about ten minutes. The coffee is ready for use when the powder swimming on the surface falls to the bottom on slightly stirring it. This method gives a very aromatic coffee, but one containing little extract. Boiling, as is the custom in the East, yields excellent coffee. The powder is put on the fire in cold water, which is allowed merely to boil up a few seconds. The fine particles of coffee are drunk with the beverage. If boiled long, the aromatic parts are volatilized, and the coffee is then rich in extract but poor in aroma.

Coffee does not retard the action of the bowels, as strong infusions of tea generally do, partly because there is less of the astringent principle, and also owing to the presence of the aromatic oil which tends to move the bowels. The important offices which coffee fulfills are, to allay the sensation of hunger; to produce an exhilarating and refreshing effect; and, most important of all, to diminish the amount of wear and tear, or waste of the animal frame, which proceeds more or less at every moment. The grounds of coffee are very nutritious, from containing so much legumin; and some of the Eastern nations take advantage of this and use the grounds as well as the infusion. In many other respects, coffee possesses similar properties to tea.

An endless variety of apparatus have been contrived (and some of them of great complexity) for preparing coffee for the table. The chief object aimed at is to obtain the liquor free from all sediment. One of the simplest of these contrivances is the percolating coffee-pot. The easiest way of making coffee, requiring no special apparatus, and as satisfactory in the result, perhaps, as any, is to put two ounces of coffee into a small saucepan or coffee-pot; pour over it a pint of boiling water, and allow it to stand, closely covered up, by the side of the fire (but *not* to boil) for five minutes. The liquor may then be simply poured off the grounds, or it may be strained through a cloth, and then returned to the saucepan or coffee-pot (previously rinsed out), and warmed again. Soyer recommends that before the boiling water is poured in the saucepan should be set dry on the fire, and the powder stirred till it is quite hot, but not in the least burned. In France, a pint of boiling milk is added to a pint of coffee. The chief effect of adding chicory to coffee is to deepen the color.

For special cases, such as journeys and marches, where it is impossible to be burdened with the necessary machines for roasting and grinding, coffee may be carried in a powdered form, and its aromatic properties preserved by the following process: One pound of the roasted berries is reduced to powder and immediately wetted with a syrup of sugar, obtained by pouring on three ounces of sugar two ounces of water, and allowing it to stand a few minutes. When the powder is thoroughly wetted with the syrup, two ounces of finely-powdered sugar are to be added, mixed well with it, and the whole is then to be spread out in the air to dry. The sugar locks up the volatile parts of the coffee, so that when it is dry they cannot escape. If coffee is now to be made, cold water is to be poured over a certain quantity of the powder and made to boil. Ground coffee prepared in this way, and which lay exposed to the air for one month, yielded, on being boiled, as good a beverage as one made of freshly-roasted berries.

COFFER-DAM.—A water-tight structure used in engineering for excluding the water from the foundations of bridges, quay-walls, etc., so as to allow of their being built dry. Coffer-dams are generally formed of timber piles driven close together (called sheeting) in two or more rows, according to the depth of water and the nature of the bottom; the space between the rows, which may vary from four to ten feet, being spooned out down to the solid and impervious bottom, and filled up with clay puddle. Sometimes they are made of only one row of piles of the full height, calked above low water, with a low or dwarf row outside to confine the puddle up to that level, or, where there is no wave or current, with a mere bank of clay thrown against the outside; and occasionally the upper work is formed of horizontal planking, fixed on open main piles, and calked in the joints. When the bottom is rock, so as to prevent piles being driven, and is not much below low water, coffer-dams are occasionally formed of two stone walls, with a space between filled with clay.

The coffer-dams spoken of are all what are called high-water dams, and exclude the water at all states of the tide. They require to be provided with sluices, to allow of the water, when first to be excluded, getting out during the ebb, and to shut against it during the flood. The remainder of the water, and all leakages, must be got rid of by pumps, generally worked by a steam-engine. For moderately shallow foundations, and more especially where there is a great rise and fall of tide, tidal dams are often used. These are sometimes made of sheeting-piles, but are often boxes formed of planking or of iron, weighted and sunk into the ground by digging inside in the same way that wells are sunk. These dams can only be used for a couple of hours or thereabouts at low water, and of course require to be pumped out every tide. All coffer-dams require to be strongly shored within, to prevent their being forced inwards by the pressure of the external water; and the rows of piles require to be strongly bolted together, to overcome the pressure of the clay puddle, which otherwise would burst them.

COFFER-MAGAZINE.—A magazine of coffer-work formed by making the frames of six-inch scantling; each frame is composed of two uprights, termed *stanchions*, and a cap and ground-sill, well nailed together; it is six feet wide, and six feet high in the clear. These frames are placed upright, and parallel to each other, about two and a half feet apart; they are covered on the top and sides by 1½-inch plank, which is termed a *sheeting*. The magazine otherwise is constructed in the usual manner. See *Magazine*.

COHESION.—The name given to that species of attraction by which the particles of matter are held together so as to form bodies, and its measure is the resistance which bodies offer to any mechanical force tending to separate their parts. In gaseous bodies cohesion is altogether wanting; their atoms even repel one another. In liquids, notwithstanding the ease with which the particles slide on one another, the operation of cohesion is distinctly seen in the formation of drops. Cohesion is strongest in solids; and degrees of cohesion, in this case, are much the same thing as degrees of solidity. It is the force of cohesion that constitutes the strength of materials. After the particles of a body have been completely separated, it is found that through cohesion they will reunite, if pressed sufficiently close together. Two clean, smooth, freshly cut pieces of lead placed together will cohere so as to require a very considerable force to separate them; and it has not unfrequently happened in plate-glass manufactories that polished plates of glass have cohered so completely that they have been cut and worked as a single piece.

If the particles of matter had no property in relation to one another, except their mutual impenetrability, the universe, it has been said, would be like a mass of sand, without variety of state or form. As it exists, however, it demonstrates the cross-action of several universal properties of matter. Among those which most affect its state and form are heat and cohesion. It may be said that bodies assume the solid, liquid, or aëriform states, just according to the proportion that the cohesion of their particles bears to those forces which, like heat, tend to separate them. Upon modifications of the cohesive force, and its relations to other molecular forces, would seem to depend such properties as elasticity, brittleness, ductility, etc.

COHORT.—In the ancient Roman armies, a cohort was a portion of a legion, consisting usually of 600 men. Generally there were ten cohorts to a legion. Marius introduced the cohort instead of the maniple as the unit of force; forming it of three maniples, and abolishing the ancient modes of classification. The cohort preserved both the number and designation of the officers attached to the maniples. It was commanded by the First Centurion, until, under the emperors, it received a Superior Officer, termed the Prefect of the Cohort. The use was also introduced of making of the first cohort a *corps d'élite*, to which was intrusted the eagle, under the orders of its primiple. The order of battle by cohorts depended upon circumstances; usually five were placed in the first and five in the second line. The number of ranks of the cohort was also variable; depending on the front necessary to be presented to the enemy.

COIF.—Among the armor of the Middle Ages, the coif was a sort of defensive hood, surmounted by a helmet, sometimes continuous with the hauberk, and sometimes separate. See *Armor*.

COILED TUBES.—The pig from which is made the bar-iron employed at the West Point foundry in the fabrication of tubes for gun-conversion is derived chiefly from the Lake Champlain magnetic ores, and from some of the hematite ores of Pennsylvania, the suitable proportions of kind and grade to yield a satisfactory metal being the result of much careful experiment. The various operations of puddling, rolling, etc., differ in no particular respect from the ordinary methods employed, except in the greater care exercised to secure a high standard for the quality of the product. A brief notice here will therefore suffice. The charge of pig-iron is first heated to redness by the waste heat from the reverberatory furnace, and is then thrown into the hearth along with a quantity of cinder. The charge consists of 448 pounds, the yield of blooms amounting to about 95 per cent of the metal charged; the amount of coal consumed is 2375 pounds per ton of puddle-bars, and the time occupied from the charging of the furnace to the withdrawal of the puddle-balls is about 1¾ hours. The process in the furnace is what is termed the "boiling process," and the regulation of the draught during this period is an operation requiring great care and good judgment, as upon it the quality of the bar-iron will in great measure depend. It is important that the iron designed for gun-tubes shall not be too "dry," i.e., deficient in cinder, as such an iron crumbles under a high heat, and, at best, welds but imperfectly. On the other hand, the presence of any considerable quantity of cinder indicates an insufficient "working," besides furnishing for the bore of the gun a material that is not sufficiently homogeneous and compact to resist well the eroding action of the powder-gases. The puddle-ball, under the action of the hammer, is formed into a bloom about 18 inches long, by 4 or 5 inches square, and weighing about 100 pounds. The blooms, before cooling, are passed between the rollers—both "roughing" and "finishing"—and result in what are termed "muck-bars," long flat bars from 4 to 2 inches wide, and ⅝ inch thick. The "muck-bars" are cut up and piled. The piles are then placed in the furnace and raised to a white heat, when they are subjected to a succession of rollings, by which they are converted into bars about 23 feet long and ½ inch thick. Each time, before being passed between the rollers, the piles are turned one fourth round, so that the compression of the metal takes place in directions that are alternately parallel and perpendicular to the layers. The operations of cutting, piling, and rolling are then repeated, and the resulting bar or plate cut into lengths of 53 inches, and piles made about 9½ inches high by 7 wide, for the final rolling. The top and bottom plates of these last piles are about ⅝ inch thick, while the intermediate plates are ½ inch thick. At this stage the piles are passed between the rollers, at first with the layers horizontal, but are afterward so manipulated that the corners of the piles shall take the groove in the rollers. The precaution is taken in heating the piles to separate slightly the successive layers, in order that the heat may more readily penetrate the mass, and both in piling and rolling the iron it is important that the direction of the fiber should be preserved always the same. In the finished bar the elementary plates stand parallel with the depth, the position most favorable to their final consolidation in the subsequent process of coil-welding. The length of the bar is about 23 feet, and the cross-section hexagonal in form, to compensate for the changes in form incident to the process of coiling.

By making the bar simply trapezoidal in cross-section, it was found that in coiling the sides become concave, thereby forming a pocket which, in the subsequent process of uniting the folds of the coil, served as a receptacle for cinder, and proved an obstacle to perfect welding. In order to avoid a feature so objectionable the shoulders were added, whence a supply of metal can be drawn to fill up the cavity of the sides. The ends of the finished bar are cut off to where the material is thoroughly welded and perfectly sound, the greater length being taken from the end nearer the furnace-door, as being the colder end. The bar is now ready for shipment to the foundry.

	Sample marked English.	Sample marked American.
Sulphur	0.047	0.037
Phosphorus	....	Trace.
Manganese	0.374	1.228
Silicon	0.018	0.089
Slag and oxide of iron	1.308	2.144
Carbon	0 094	0 034
Iron	98.159	96.468
	100 000	100.000

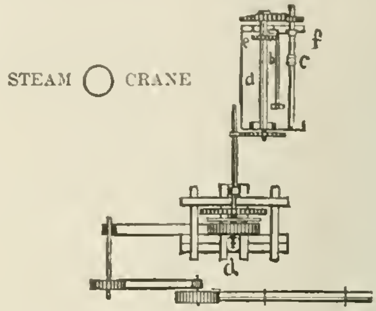
The table herewith exhibits a resemblance between the two varieties of iron which is remarkable, since the American manufacturers possessed no accurate knowledge of the mode of fabrication of the English iron, but were guided almost entirely in their efforts by such imperfect data as could be gleaned from reports of Parliamentary Committees on the failure of a large number of coiled wrought-iron tubes in England; reports of which the chief value lay in their pointing out the nature of existing defects in material and manufacture, rather than the course of practice by which those defects might be removed or avoided.

The bar-iron, as received at the foundry, is in lengths of 16½, and 18 feet for the A tube, and of 26 feet for the B tube, the cross-section of the latter being a square of 2¾ inches on a side. The weights are about as follows:

	Pounds.
Long bar for A tube	749
Short bar for A tube	678
Bar for B tube	608

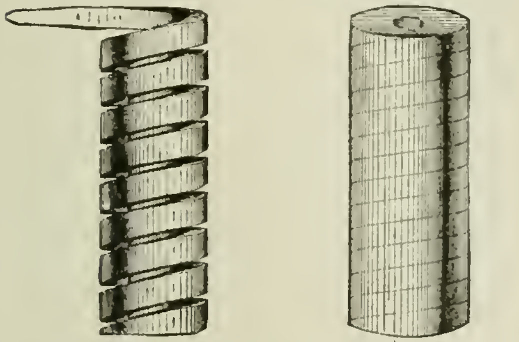
The A tube is composed of four sections or short tubes welded together, each section, as well as the B tube, consisting of two bars, which are united end to end before coiling. The long bars for the A tube are employed in the breech-section, in order to give that section such length that the joint between it and the next section shall be well in advance of the B tube.

To prepare the bars for welding they are sorted in pairs, and the ends to be united shaped for scarfing. At the same time the other ends are tapered by heating and hammering, and an eye and shoulder formed for purposes in coiling. The V scarf, by affording a firm grasp to the ends, and by exposing a large surface for welding, is thought to insure a strong joint; yet so great is the strain thrown upon the bar in the operation of coiling that separation does sometimes take place at that point. The welding is readily performed by means of a "hollow fire" and an adjacent steam-hammer. The joint is subjected to three heats. At the first heat the bars are butt-welded by means of sledges; at the second and third heats the joint is lap-welded by the steam-hammer, the hexagonal cross-section being afterward restored by interposing a wedge-shaped tool between the bar and the hammer. While in the fire, one end of the bar abuts against a heavy timber, and the other end is repeatedly struck upon with a sledge to close and upset the joint. The coiling process is a familiar one, the method pursued at West Point differing in no important respect from the English method. The grates and ash-pits, seven in number, are ranged along one side, and the draught enters under the grates. The blower is worked by the engine that revolves the coiling apparatus. The number of fires employed at any one time depends upon the length of the bars to be heated. About ninety bushels of anthracite coal a day are consumed in each grate. At the rear of the oven is a roller-way upon which the bars are moved into the oven. The slope of the oven and trestle-work facilitates the insertion of the bars; but, as a feature of the construction, it resulted rather from the inclination of the ground on which the oven is built than from design. The bars are pushed into the oven as far as it is possible to push them, and then a long iron hook is passed in from the front and hooked into the eye in the end of the bar. A chain leading from the windlass of a steam-crane is connected with the hook, and the bar is drawn forward by the revolution of the windlass. It requires about three hours to heat the oven, and after that about one hour to heat the iron to a bright redness, the temperature required. The oven has a capacity for eight bars; but, to secure greater facility in handling, more than four are seldom heated at once. The coiling apparatus is shown in the drawing: *a* is a mandrel, slightly conical in form, on which the bar is wound; *b* is a roller-guide over which the bar passes, and by means of which the exterior diameter of the coil is regulated; *c* is a sliding guide which regulates the spiral of the coil. At *d* is the steam-piston which communicates the motion. On the mandrel is an iron disk, *e*, through which is inserted a pin or key, *f*, and the end of the bar is attached to the mandrel by passing between it and the key, and hooking over the latter by means of



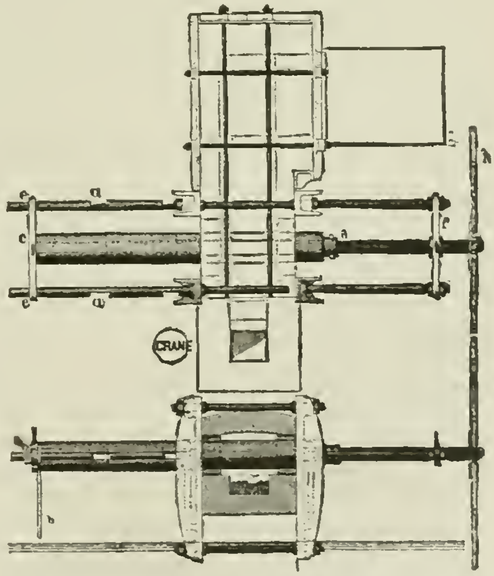
the shoulder. In this position the narrow side of the bar is down or against the mandrel. The apparatus having been put into gear, the mandrel revolves, winding the bar around it. To remove the coil the apparatus is thrown out of gear, the cap-squares of the mandrel are removed, and, by means of the steam-crane standing immediately in rear, the mandrel is unshipped and swung round. The coil is then started by driving in wedges between the end of the coil and the disk, *e*, after which it is readily removed. After coiling, the cross-section of the bar is slightly concave on the exterior and convex on the interior of the coil, while the distances between the folds are less on the interior than on the exterior. It requires one hour to coil four bars.

When removed from the mandrel, the ends of the bar project out from the coil, and the folds are very open, varying from ⅜ to 1¼ inch on the exterior. The ends are therefore heated and hammered round to conform to the curvature of the coil. The next step is one of closing the folds and welding them. For these operations there are provided two cast-iron tubes, banded with wrought-iron hoops, termed "welding-pots." These pots are cylindrical without, but slightly conical within, and are of two sizes, the diameter of the smaller being 14¼ inches, and of the larger 14⅝ inches, at bottom. In connection with the pots is used a short iron cylinder about 9 inches in height and 14 inches in diameter, termed the "cheese," which receives directly the impact of the hammer. The coil is at first heated to redness in an ordinary reverberatory heating-furnace, and then transferred, by means of a porter-bar suspended from a crane, to the smaller welding-pot, where it is simply pressed under the hammer. The effect of this operation is to close the folds along the surface of the bore. The porter-bar is provided with a heavy sliding counterpoise to facilitate handling it. In order to avoid weak or imperfect welding of the folds, it is desirable that the process should commence at the interior surface of the coil and progress gradually outward, thus leaving to the last an open joint at the exterior for the escape of the cinder squeezed out in the operation. This end, it is thought, is secured by the particular form of cross-section given to the bar, and by the precaution taken of first closing the folds along the interior surface before proceeding to the welding. The coil is now replaced in the furnace and subjected to a welding-heat, which occupies from 2½ to 3 hours. It is then removed to the smaller welding-pot, and the "cheese" dropped upon it, and hammered till the latter sinks to a certain mark chalked upon it. The pot is then turned over, and the coil withdrawn by means of blocks and tackle. The coil is then heated for the third time, and the same operation as above repeated, except that the larger pot is employed. The length of the coil after closing folds is about 4¼ feet, and the exterior diameter 13 or 13½ inches. After being withdrawn from the large pot, the length is about 3 feet; the exterior diameter about that of the pot, and the interior diameter from 5 to 7 inches. The width of fold in the coils for the A tube is now about 2.75 inches, while in those for B tubes it is about 2 inches. The hammer employed in welding the coils is an 8-ton steam-hammer. The drawing shows the coil at the following stages of its



fabrication, viz.: after being removed from the mandrel of the coiling apparatus, and after welding of the folds. In England, the process of coil-welding differs as follows from the above: The coil having been subjected to a welding-heat, "it is placed vertically under the steam-hammer, and receives a few smart blows to weld the folds. It is then thrown on its side, and being gradually turned is hammered (or patted) all round to straighten it. It is then raised vertically again, and a punch or mandrel—rather over half the length and a little larger than the interior diameter of the coil—is hammered down its own length. The coil is next placed on its side and hammered round that half of its length, thus being made very compact, and large enough to let the mandrel fall out. After this the coil is again raised vertical, and the mandrel is forced in the opposite end, and the process repeated. The reason a long mandrel is not forced through the whole length of the coil is that it would tend to separate the folds. The coil is replaced (upright) in the furnace for the second heating, and much the same process is followed to render the ring more consolidated as well as more shapely." By the American process, there seems to be no tendency whatever to separate the folds during any part of the operation. The coil is withdrawn from the welding-pot by connecting the tackle with an iron rod, which passes down the interior of the coil, and is held by a key at the bottom, so that the strain is transmitted to that point.

After welding the folds, the coil is extremely rough and uneven on the interior; it is therefore removed to the shops, where it is rough-bored to within .75 inch of the true diameter of the tube, which furnishes a straight and uniform bore for the formation of the tube. The exterior is comparatively smooth and cylindrical. To unite two or more coils to form a tube, the ends are faced and reciprocally recessed; that is, a projection is formed at one end of a coil, while a recess is bored in the corresponding end of another coil. The height of the projection is a little greater than the depth of the recess, in order that a close joint may be obtained on the interior. The recess is then expanded by heat and shrunk over the projection, so that the two coils are sufficiently stuck together to admit of being put into the furnace for welding. An iron rod, with a key at one end and a nut on the other, is passed through the sections, and the nut screwed up to prevent separation in shrinking. The furnace for welding the sections is so constructed that an intense heat shall act only upon the joint. The butt-welding is performed by means of a powerful screw-press. The furnace and welding apparatus are shown in the following drawing. The tube is placed in the furnace by means of a crane and a porter-bar; the bars *a a* are then raised on the supporting-props *b*, the cross-head *c* and the screw *d* adjusted to the ends of the tube, and the wedges *e* inserted. The furnace is then entirely closed around the tube, and the draught turned on. It requires about three hours to raise the temperature of the metal on the interior of the tube to a welding-heat, a point which is ascertained by means of a hole pierced through the cross-head *c* and covered with a plate of mica, which permits of the interior of the tube being seen. A welding-heat being obtained, the screw, which works in the cross-head *f* as a nut, is tightened by means of the handle *h*, till the tube is compressed lengthwise ½ inch. The tube is then turned half around, the heat renewed for about ten minutes, and another turn given to the screw, by which a further compression of ½ inch is obtained. The props are then knocked out, the bars fall down, and the tube, which is considerably bulged at the joint by the compression it has undergone, is removed to the steam-hammer and "patted" into shape, as well as lap-welded. Sand is thrown on the joint during this operation, to protect the iron and prevent the formation of scale. The face of the hammer, as well as the top of the anvil, is semi-cylindrical, to conform to the exterior of the tube. Two sections being thus welded together, another is added in a similar manner, and then another section which completes the tube. The English method of welding the sections is as follows: After shrinking two sections together, as above, the tube is put crossways through a furnace so constructed that the heat acts only on the joint. When the joint arrives at a welding-heat, a stout iron bar is passed through the tube; this bar is keyed up at one end, and



by means of a screw-nut worked by a long lever at the other end, the two coils are welded or pressed together. The joint is afterwards tapped under the hammer. The furnace and apparatus as described for welding sections were devised by Mr. Colin Tolmie, Superintendent of the Forge-shops at the West Point foundry, and the experience so far had with them has been very satisfactory. The furnace has a capacity for about 1500 pounds coal (anthracite coal being employed) and is so arranged as to consume its own gases. The amount of coal consumed in welding thirteen sections is about 6900 pounds. It requires ten hours to heat up the furnace when cold, and about four hours when working daily. The fire is always replenished during an interval when the tube is withdrawn, so as not to interfere with the heating. While in the furnace, should the joint become unequally heated, sand is thrown in upon the hotter part to equalize the temperature.

The tube is now transferred from the forge to the shops, and placed in the lathe, where it is rough-turned and rough and fine bored. The breech-cup is then screwed in, the breech end of the tube turned down over a length of 32 inches for the reception of the B tube, and the spiral gas-channel cut upon it. The breech-cup is a solid forging stamped into shape under the steam-hammer, turned inside and out, and screwed on the exterior with a thread of five to the inch. The B tube consists of two bars united, coiled, etc., in the same manner as a section of the A tube. It is rough-turned to 13.75 inches, the exterior diameter of the main portion of the A tube, and finished bored to 10 inches. It is shrunk on the A tube with .003 inch shrinkage in the diameter. The shrinking operation is a simple one. The B tube stands vertically, breech down, over a wood-fire, while a large open cylinder of sheet-iron surrounds it. When sufficiently heated the A tube is lowered by a crane into place, the weight of the A tube forcing the B tube well "home" to the shoulder upon the former. Water is then thrown upon the exterior near the shoulder, to cool the B tube in that vicinity first, and thus prevent an open joint, which is apt to occur from the longitudinal contraction of the B tube in cooling.

The tube at this stage is subjected to a water-test of 140 pounds to the square inch, and is turned to fit the casing, allowing a "play" of .007 inch in the diameter between it and the casing for a distance of 32 inches from the bottom, and of .015 inch for the remainder of its length To determine this play, it is necessary to accurately measure the diameters of the bore of the casing and of the exterior of the tube; the former are measured with the star-gauge, the latter either by means of horseshoe-gauges or a diameter-calipers specially designed for the purpose, and measuring to .001 inch. The tube is rifled either before or after its insertion into the casing, as may happen to be most convenient. The weight of bar-iron employed is about 6770 pounds. The weight of the finished tube is about 3100 pounds. The operations of inserting the tube into the casing and securing it, of venting, final proof, etc., are fully described in the fabrication of converted guns. The collar for securing the tube at the muzzle is made of tube-iron, fagoted and hammered out to a proper size. It is then bent to a circle over a mandrel, and the ends welded together. See *Converted Guns*, *Fabrication of Tubes*, and *Water-test*.

COIN.—In gunnery, a kind of wedge to lay under the breech of a gun in order to raise or depress the metal. Written also *Quoin*.

COIR.—The fiber of the cocoanut. Very excellent rope for naval purposes is made from it, and is valued on account of its lightness, elasticity, and strength. Coir-cable is prepared in Ceylon, on the Malabar Coast, in the Maldive and Laccadive Islands, and in most places along the eastern and western coasts of the Bay of Bengal, where cocoanut-trees grow. Sponges for guns have been made from the fiber, but they are not equal to sponges made of wool for this purpose, and are, moreover, liable to take fire.

COKE.—A fuel much used for melting iron in the foundry cupola, and obtained by the heating of coal in ovens, or other arrangements where little air is admitted. Caking coal is most suitable for the manufacture of coke. The process is conducted either (1) in heaps or ridges, or (2) in ovens. The coking in heaps is called the Meiler method, and consists in placing the coal in round stacks, or in long ridges, occasionally to the length of 200 feet. During the building of the coal, wooden stakes are driven in, which are afterwards taken out, and lighted coal introduced at numerous places at the same time. As the coal becomes heated, much smoke and vapor are evolved, which mainly consist of tar, water, and coal-gas. Whenever the smoke ceases to be evolved, the process of coking is regarded as concluded, and the mound or ridge of red-hot cinder, or coke, is covered over with fine coal-dust, which, excluding the air, extinguishes the combustion. At places where the operation of coking is conducted regularly on the large scale, it is customary to erect brick chimneys or columns, about the height of the proposed mound, and to build the coal round these, placing the larger masses in the center, the smaller pieces outside, and ultimately covering the whole with fine coal or dross.

A more economical plan of preparing coke is to introduce the coal into fire-brick ovens. The coal is introduced by the top, and being lighted, a little air is admitted by openings in front. Whenever the coal ceases to evolve smoky vapor, every opening is closed, and the oven is allowed to cool down for 12 to 24 hours. A door in front is then opened, and the coke being raked out whilst still hot, water is thrown upon it, to stop the combustion. Small coal may be used if it belongs to the caking kind; and a little water sprinkled over it causes the caking operation to proceed more completely. The proportion of coke obtained from coal in Great Britain ranges from 54 to 73 per cent, so that in round numbers the better class of coal for this purpose loses a fourth of its weight. At the same time the coal increases in volume to the extent of about one fourth. Coke is a hard, brittle, porous solid, with a color varying from iron-gray to blackish gray, and more or less of a metallic luster, and does not soil the fingers. It absorbs moisture from the air, sometimes to the extent of 30 per cent, and contains an amount of ash ranging from ½ up to 15 per cent. It gives off no smoke in burning, is of great value as a fuel, evolving a very large amount of heat.

The advantages of coke of the best quality (Connellsville coke) may be enumerated as follows: 1st. Coke will melt iron much more quickly than coal. 2d. Coke melts iron so much softer than any other fuel as to save very considerably on that alone, by making solid and perfect castings. 3d. One pound of coke will melt two to four pounds more iron than a pound of coal. 4th. Coke makes minimum quantity of slag. Furnace does not have to be "picked out" when coke is used. 5th. Coke requires much less blast. 6th. Coke contains the smallest percentage of sulphur and other impurities, and the highest percentage of fixed carbon. 7th. By melting the iron very soft and hot, it admits the use of much more scrap than with any other fuel. 8th. On account of saving in time, reduction of strain on blowers and power for blast, there is a consequent great saving in labor and other general expenses. 9th. A good, clean "drop" at end of heat, and furnace is left in good shape. See *Anthracite* and *Coal*.

COLD-BLAST.—Air forced into a smelting-furnace at a natural temperature, in contradistinction to a heated blast, which is more economical, but produces an inferior quality of iron.

COLD-SHORT.—A void or seam in a casting occasioned by the too-rapid congelation of the metal, which failed to fill the mold perfectly.

COLD-SHORT IRON.—Iron containing phosphorus, which may be forged and welded while hot, but is brittle when cold.

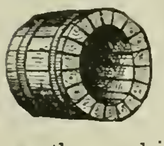
COLDSTREAM GUARDS.—A regiment in the Foot-guards or Household Brigade; it is the oldest corps in the British army except the First Foot. General Monk, in 1660, raised a corps at Coldstream, which was at first called "Monk's Regiment;" but when Parliament consented to give a brigade of guards to Charles II., this corps, under the name of Coldstream Guards, was included in it.

COLIC.—A complaint with which horses are not unfrequently attacked, caused by indigestion, constipation, spasm, strangury. The remedy for this complaint is thus explained: The attack will generally yield to the first or second dose of the usual colic-mixture, with injections of warm soap-and-water, and with a little spirits of turpentine in it; friction being used to the surface of the belly. If there is constipation, give a dose of the prescribed mixture, with a teaspoonful of ginger in it; if the pain continues and becomes more constant, bleed, taking from six to ten quarts of blood, continue the injections, and give a dram of opium every hour, blister the belly, clipping the hair off first. The cure for colic is powdered opium, 1 dram; ginger, powdered, 2 drams; allspice, powdered, 3 drams; caraway-seeds, powdered, 4 drams—made into a bolus.

COLICHEMARDE.—A variety of sword in great favor for dueling in the reign of Louis XIV. Its peculiarity is, that from the hilt the blade for some length is tolerably broad, then suddenly by a rectangular step, on each side, it becomes narrow, and terminates in a very sharp point. This conformation of the blade has the advantage of placing the center of gravity in the hilt, and consequently the weapon is remarkable for its lightness and convenience in the hand. This is sometimes called *Königsmark sword*, and the word *Colichemarde* is only a corruption of the word Königsmark.

COLISMARDE.—A long slender sword used in ancient times; a combat-sword. See *Colichemarde*.

COLLAR.—A device placed upon the chase of a gun to make its diameter equal to that of the body of the piece. This enables the gun to be rolled with facility. It is made of pieces of scantling jointed together after the manner of the staves of a cask, and hooped with stout bands of iron. It is shoved over the muzzle on to the chase, and is secured with wedges of wood.



COLLAR-MAKERS.—Artificers appointed for the repair of draught-harness. In the English artillery, on first appointment, they have the rank and clothing of Bombardiers, and reckon service, as such, without increase of pay. After five years' service, if Bombardiers, they have the rank and clothing of Corporals, and reckon service for pension, as such, without increase of pay. The four senior Collar-makers of each brigade are allowed the rank and clothing of a Sergeant, but without increase of pay.

COLLEGE OF ARMS.—A collegiate body, founded by Richard III. in 1483, consisting of the heraldic officers of England, who were assigned a habitation in the parish of All-hallows-the-Less, in London. Various charters confirmed the privileges of the College of Arms, and it was reincorporated by Philip and Mary, who bestowed on it Derby House, on whose site in Doctors' Commons the present College was built by Sir Christopher Wren. The presidency of the College is vested in the Earl Marshal, an office now hereditary in the family of Howard Duke of Norfolk; he nominates the three kings of arms, six heralds, and four pursuivants, who are the members of the collegiate chapter. Persons having a hereditary claim to arms, which has been disused for one or more generations, are empowered by the Heralds' College to resume them, on proof and registration of pedigree. A person who has no hereditary claim, and wishes a grant of arms, must memorialize the Earl Marshal, and show that he is in a condition to "sustain the rank of gentry." An important department of the College is the recording of pedigrees. Any pedigree showing the existing state or descent of a family may, if accompanied with sufficient evidence, be entered on the books of the College. The members of the College have salaries, but derive their principal income from fees charged for assistance in tracing pedigrees and titles, and for the granting and registration of arms. In Scotland the corresponding functions belong to the Lyon Court. See *Heraldry*.

COLLET.—In gunnery, that part of a cannon which is between the astragal and the muzzle.

COLLETIN.—The ancient name for that part of the armor which protected the neck and upper part of the breast. See *Armor*.

COLLIMATOR.—An instrument for laying guns and mortars, and especially adapted for laying them for night-firing. But the same appliance as is used by night could be made available by day, with the embrasures closed, thus protecting the gunners from the fire of the enemy.

COLLODIONIZED-PAPER PROCESS.—Paper being substituted for glass in this process, as a basis upon which to support the film, a great increase in portability is arrived at, as the sensitive sheets may be carried in a portfolio, and employed in the same manner as dry collodion plates. There are difficulties, however, in the way of its successful practice, which have prevented it from becoming as popular as it deserves to be. The following is a brief summary of the manipulations. Mr. Corbin, the inventor of the process, ascertained that a peculiar collodion was requisite, the formula of which is as follows: ether, 650 parts; alcohol, 350 parts; pyroxyline, 15 parts; iodine, 1¼ parts. The collodion so prepared is poured on the glass in the usual way, and sensitized in a bath containing only 1 per cent of nitrate silver and ½ per cent of nitric acid. The plate having remained in this bath about 2 minutes, is withdrawn, and freely washed with water; it is then immersed in a solution of 1 per cent of iodide of potassium, to insure the complete decomposition of the whole of the free nitrate of silver not removed by the washing. A piece of negative paper is now coated with a solution of gelatine, containing 6 parts gelatine to 100 parts water; the dimensions of the paper should be rather less than the glass, and the gelatinized side is brought into contact with the collodion film in a dish of water, any intervening water being expelled by passing a glass rod lightly over it. The edges of the collodion film which project beyond the paper are folded back on it, and the film and paper removed together. The now collodionized paper is laid, film uppermost, on a glass plate, coated with a preservative solution, composed of equal parts of albumen and honey, diluted sufficiently to enable it to flow freely over the paper. The film is lastly sensitized in a solution of nitrate of silver, 5 parts; glacial acetic acid, 5 parts; water, 100 parts; it is then freely washed as before in water, and hung up to dry. As it is apt to wrinkle in drying, it should be attached by all four corners to two lines, running one under the other. See *Photography*.

COLONEL.—The highest officer of a regiment; any grade above this converts him into a General Officer belonging to the army collectively, rather than to any one regiment. Before the reign of Elizabeth the chief officer of an English regiment was Captain, but in 1588 the title of Colonel had become familiar. In the British army at the present day, except in the Artillery and Engineers, the office of Regimental Colonel is a sinecure, the real active Commander of the Battalion being the Lieutenant Colonel. The Colonel receives higher pay and dignity. The Colonels are Generals who have had what is called a regiment "given to them" as a reward for long service, and virtually as a retirement. The pay, except in the Guards (where it is higher), is £1000 a year. The army estimates provide for about 150 regimental (otherwise called "honorary") Colonels of Cavalry and Infantry, and for about a sixth of that number Colonels Commandant in connection with the Artillery and Engineers. There is a frequent outcry against these appointments when viewed as sinecures, but looked upon as retirements for deserving old officers there is little that is objectionable in them. The rank of Colonel was above those which were purchasable. Apart from regimental rank there is the army or brevet rank of Colonel, through which all officers must pass on the way to General Officer. It is attained by specified service in certain positions as Lieutenant Colonel. In the Austrian, Prussian, and Russian armies, where the regiments are very large, the Coloneleies are mostly honorary posts, held by Emperors, Kings, Princes, and other distinguished persons. There is no material difference in the position of Colonel in the American as compared with the British army. The rank is between Lieutenant Colonel and Brigadier General, and the extent of command is usually a single regiment.

COLONEL COMMANDANT.—The Chief of a Brigade of Artillery, Engineers, or Marines, in the English service. This position is analogous to that of a Colonel of a Regiment, who receives what is termed the "Colonel's Allowance." In the early days of this rank in the Artillery, the connection of the Colonels Commandant with their battalions remained of the closest description. No officer was allowed to be promoted, under the rank of Field Officer, without a recommendation from the Colonel Commandant of the battalion in which he might be serving. Nor was any exchange allowed without the consent of both the Colonels Commandant concerned. Even nowadays, before an Adjutant is appointed to a Brigade of Artillery, the Colonel Commandant has to be consulted, and nominates the officer subject to the approval of the Commander-in-Chief.

COLONEL GENERAL.—An honorary title, or military rank, which is bestowed in foreign services. Thus, the Prince of the Peace in Spain was Colonel General of the Swiss Guards.

COLONIAL ALLOWANCE.—An allowance granted to British regiments in certain Colonies to meet the extra expenses of foreign service. The amount varies with the Colony; in some it is half as much more as the ordinary pay; in others it is more. The names of the Colonies at which a colonial allowance is granted are the Mauritius, Ceylon, Straits, China, West Indies, Africa, Cape of Good Hope. No such allowance is granted to regiments in Canada. Australia and New Zealand have no British troops.

The only advantage enjoyed by troops in the Mediterranean is the issue of "extra rations." Regiments in India receive Indian pay.

COLONIAL CORPS.—Certain regiments forming part of the regular army of the British Empire, and paid for out of the Imperial Revenues. They were never very fixed in number, varying with the circumstances of the Colonies in which they were located. The following were the names of the Corps, the numbers provided for in the army estimates for 1860-61, when these regiments were at their largest recent establishment, and the composition of each Corps, whether British or native:

Three West India regiments (afterwards raised to five)	3,420	Negro.
Newfoundland Veterans...	229	British.
Ceylon Rifles............	1,585	Native.
" Invalids..........	163	Native.
Cape Mounted Rifles......	1,084	Boers and natives.
Malta Fencibles..........	638	Native.
Canadian Rifles..........	1,106	British.
St. Helena Regiment......	433	"
Gold Coast Artillery......	351	Native.
Falkland Islands Company.	37	British.
African Artillerymen......	64	Native.
Hong Kong Gun Lascars..	88	"

These Corps, comprising about 95 companies, had somewhat over 1000 officers, commissioned and non-commissioned, and about the same number of horses. All the Corps were officered by British, except the Malta Fencibles. The Cape Mounted Rifles was a Mounted Infantry Corps.

As the Colonies obtained self-government, and the military theory of employing troops only in large bodies gained ground, it was considered as against Imperial Polity to maintain, out of the Imperial Revenue, Corps which were tied to one Colony, and not available for the general defense of the Empire. Accordingly the Colonial Corps have been gradually disbanded, and there survive only two West India regiments and the Malta Fencibles.

COLOR-BEARER.—The bearer of the colors. The Color-sergeants are the Regimental Color-bearers. See *Color-sergeant*.

COLORED FIRES.—The materials for colored fires should be as pure as can be obtained; those which crystallize should be procured in the crystalline state. They should be generally first dried, ground fine, weighed out and mixed. The composition is then moistened and pressed into shape. Some of the materials, such as the flowers of sulphur and lamp-black, ought to be first well washed in warm water. Antimony, glass, copper filings ought, as well as other materials, to be passed through sieve No. 1. All the materials should be perfectly dry. Those which contain water of crystallization, as the barium nitrate, strontium nitrate, and copper sulphate, should have it driven off. For this purpose, place the salt in a broad, shallow vessel in a water-bath, or on a moderate fire, and stir it till it be perfectly dry, taking it off the fire some minutes before. As the copper sulphate is easily decomposed in this operation, and as the sulphuric acid set free might occasion a spontaneous explosion when the copper sulphate was brought in contact with the chlorates, two parts of liquid ammonia are poured by degrees on the copper sulphate powdered and yet hot. (The ammonia neutralizes the acid, and, instead of injuring the color, it heightens it. The same process should be adopted with other decomposable salts.) A thick liquid of an indigo-blue color is obtained; place it on the fire, and warm it gently until it becomes a thick paste; then, leaving only a few coals under it, stir it with a spatula and crush it into a powder.

The materials are ground in a mortar with a pestle, or on a sieve with copper balls .4 inch in diameter, of equal weight with the composition to be ground. All the utensils should be kept perfectly clean. To pulverize antimony melt it and pour it into a cast-iron mortar previously warmed; when the metal is on the point of congealing stir it briskly with the pestle; it is thus reduced to fine grains, which are then pulverized with a pestle. Zinc and other similar metals are treated in the same way. To obtain shellac in the state of a fine powder, it is first broken into pieces and melted with its weight of niter. The mass is then ground as usual, and the powder thus obtained is washed in pure water till all the niter is removed. The resins and other substances insoluble in water and, difficult to pulverize in their pure state are treated in the same manner. All materials when pulverized should be passed through hair-sieve No. 1. They ought, if possible, to be sifted when warm, and placed away immediately in well-stoppered bottles to preserve them from moisture. The chlorates should be pulverized in a marble mortar with a hard-wood pestle. The mortar, pestle, and sieve should be used only for a single chlorate, and the whole operation be performed in a place apart to avoid accidents. The chlorate can be ground and manipulated by itself without danger; but when it is mixed with sulphur, charcoal, etc., it explodes very readily.

Each material should be weighed accurately by itself, according to the proportions laid down by authority. The materials, after being weighed out, are poured on a sheet of pasteboard, and mixed as well as possible with the hand; they are then passed three times through sieve No. 2, keeping the sieve stationary, and stirring the materials with the hand. If a chlorate enters into the composition, begin by mixing all the materials on a pasteboard, except the sulphur, charcoal, lamp-black, sugar, tallow, and shellac. When they are well mixed, add the combustible materials separately, mix them thoroughly, and then add the chlorate. Pass the composition three times through sieve No. 2, using a feather for the purpose. All these manipulations with compositions into which a chlorate enters should be performed in a place aside, and with a small quantity at a time. Compositions thus prepared should be preserved in well-stoppered bottles, carefully labeled. Those containing chlorates should be placed away from the rest, and apart from each other.

Compositions are dampened by pouring the pure or gummed liquid on them, a little at a time, and mixing it well with the hand or a wooden knife. Compositions should not be dampened until just before they are to be molded. All compositions may be firmly compressed, provided care be taken to avoid friction and blows with those containing chlorates. However great the care taken in the choice of materials, their proportions and manipulations, it is difficult always to get uniform results. It is necessary, therefore, to try the mixtures and modify the proportions as may be required. In every composition there are certain substances which are used to furnish oxygen for the consumption of the rest; the nitrates and chlorates are such. There are other substances, as sulphur, charcoal, and vegetable matters, which are burned; and others which are only used to give color to the flame, as antimony, lead, copper, strontia, etc. The same substances may furnish oxygen and color the flame at the same time. Certain materials are used only to heighten the color, as the mercuric chloride and the ammonium chloride; the action of the latter is weaker than that of the former.

When a composition burns too slowly, there is an excess of coloring matter, or of that which is to be burned, or some other substance (as water, for example), very rarely of that which furnishes oxygen. When the composition burns too fast, it is necessary to add coloring matter, or such substances as sugar, rosin, or tallow, which operate by separating the substances, supplying the oxygen from those which are burned, and at the same time keeping up the combustion. Generally, the quicker the combustion the more will the flame approach to whiteness, whatever may be the coloring principle; and the slower the combustion the more certainty there will be of obtaining the desired color. See *Compositions* and *Fire-works.*

COLOR-GUARD.—In each Infantry Battalion of the United States Army there is a Color-guard, composed of a Color-sergeant and seven Corporals, which is posted as the left four of the right center company. The front rank is composed of the Color-sergeant and three senior Corporals, one posted on his right and two on his left; the rear rank is composed of the four remaining Corporals. The Corporals are placed in the order of rank from right to left. The Color-sergeant and Color-corporals are selected from those most distinguished for bravery, and for precision under arms and in marching. The Color-sergeant carries the national color. The regimental color (when present) is carried by a Sergeant, who takes the place of the Corporal on the left of the Color-sergeant.

The colors, delivered by the Colonel into the hands of the Color-bearer, are escorted by the Color-guard to the Color-company, on its parade-ground; and in like manner are escorted back to the Colonel's quarters. The Color-guard, by command of the Color-sergeant, *presents arms* on receiving and on parting with the colors; in the latter case the Color-guard returns to the carry by command of the senior Color-corporal.

The Color-guard executes the *order arms, carry arms,* the *loadings* and *firings*. In rendering honors it executes the *present, reverse,* and *rest on arms*. On drill, in addition to the above, it executes *support* and *right shoulder arms*. It executes the other movements in the manual only when specially directed. The bayonets of the Color-guard are habitually carried in the scabbard.

COLOR-PARTY.—The two Officers, in the English service, who carry the colors of a regiment; as a rule, the two junior Lieutenants. Four Sergeants are also told off to assist, of whom one stands between the two Officers and three form a rear rank.

COLORS.—1. In Heraldry, the colors used are generally red, blue, black, green, and purple; which are called gules, azure, sable, vert or sinople, and purpure. Tenne or tawny, and sanguine or blood-color, sometimes occur, but they are not common. Yellow and white, again, are not colors in the heraldic sense, but metals; they are called or and argent, and are always represented by gold and silver. It is a fundamental and invariable rule in blazon not to put color upon color, or metal upon metal; thus, if the field be of a metal, the bearing must be of a color, and *vice versa*. The only exception is said to be the arms of Jerusalem, which were given to Godfrey of Bouillon, which are *argent, a cross potence or, between four crosslets of the same*. Apparent exceptions to this rule in common blazon are (1) abatements or marks of cadency or difference, labels, crescents, batons, and the like; and (2) extremities or adjuncts to animals, or other objects, such as tongues, claws, horns, etc.; but neither of these are regarded as independent bearings. Colors and metals, when engraved, are generally indicated by dots and lines: *or*, gold, by dots; *argent*, silver, is left plain; *gules*, red, is indicated by perpendicular lines from top to bottom; *azure*, blue, by horizontal lines from side to side; *sable*, black, by horizontal and perpendicular lines crossing each other; *vert*, by diagonal lines from right to left; *purpure*, by diagonal lines from left to right; *tenne*, by diagonal lines from left to right, crossed by horizontal lines; and *sanguine*, by lines crossing diagonally from left to right, and from right to left. See *Heraldry*.

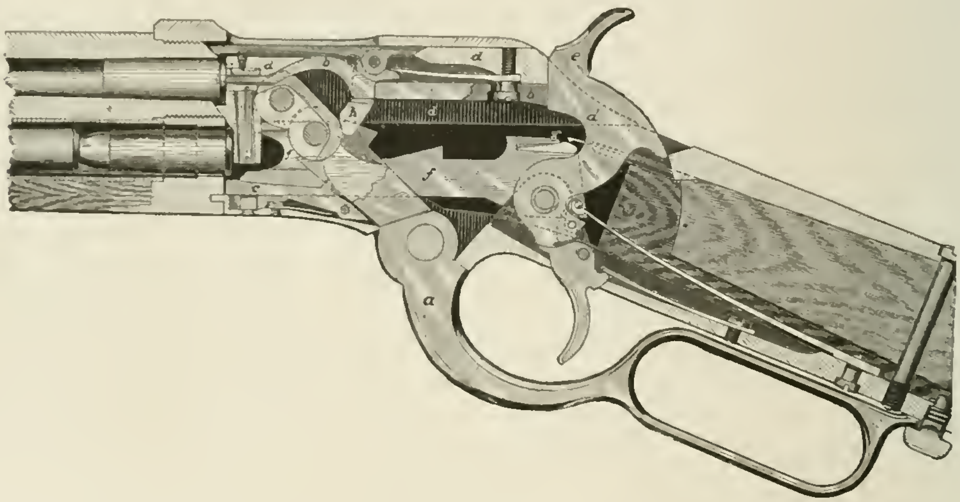
2. Certain kinds of flags carried with the army. Standards, banners, pennons, guidons, ensigns, and colors are military flags, each originally having a distinct meaning, now to some extent departed from. The ensigns were the original of those which are now called colors, and which especially belong to infantry regiments, in England. The colors are square flags, larger than the standards carried by the cavalry. In former times there was one for each company; but now there are generally two for a battalion, constituting "a pair of colors;" one of which is called the Royal or First, and the other the Regimental or Second. Both are about 6½ feet by 6, made of silk, with cords and tassels of crimson and gold, and fixed to a staff about 10 feet long. The Royal Color or Flag is nearly alike for all the regiments; with a blue ground, an imperial crown, the number of the regiment, and the union cross of St. George, St. Andrew, and St. Patrick. The Regimental Color depends for its tint on the facings of the uniform of the regiment; in its center is inscribed the number or designation of the regiment, with its crest and motto, if any; and around are the names of the victories and campaigns in which the corps has served. A subaltern officer carries the colors, and certain non-commissioned officers are set apart as a guard. The colors symbolize the good name and fame of the regiment, and are on that account protected in action with sedulous care; a victor always counts among his achievements the number of colors captured from the enemy. When a regiment obtains new colors, they are usually solemnly presented by some lady of distinction. The presentation is made with much military pomp, and the Chaplain of the Regiment reads a prayer prepared for the occasion. A member of the Heralds' College is "Inspector of Regimental Colors," the post being at present held by Garter-King-at-Arms. Besides the above, there are small camp-colors of the same tint as the facings of the regiment, to designate the part of the camp the corps occupies. Rifle regiments do not carry colors.

In the United States, each regiment of infantry and artillery has two colors, one national and one regimental. See *Artillery Colors, Camp Colors, Engineer Colors, Escort of the Color, Flags, Infantry Colors,* and *Standard*.

COLOR SALUTE.—The Color-bearer carries the heel of the color-lance supported at the right hip; the right hand grasps the staff at the height of the shoulder, to hold it steady. The Color-bearer salutes with the colors as follows: 1. Slip the right hand along the staff to the height of the eye; lower the staff by straightening the arm to its full extent, the heel of the lance remaining at the hip. 2. Bring back the lance to the habitual position.

COLOR-SERGEANT.—The Sergeant detailed to carry the Regimental Colors. He is usually selected for military deportment and soldierly bearing, and when carrying the colors is escorted by a guard of seven Corporals. In the British army the Color-sergeant is a non-commissioned officer of higher rank and better pay than the ordinary Sergeants. There is one to each company of infantry; and the office is specially given to meritorious soldiers. The Color-sergeant wears an honorary badge over the chevrons, and receives 2*s*. 5*d*. per day. He fulfills the ordinary regimental and company duties of Sergeant; but in addition to these, he attends the colors in the field, or in the front of a camp, or near headquarters in a garrison. A Color-sergeant may be degraded to the rank of Sergeant for misbehavior, but only by the decision of a Court-Martial.

COLT MAGAZINE-RIFLE.—A new rifle recently developed and perfected by the Colt Arms Company. The drawing shows the arm and its parts in the position that they will have immediately after the piece is fired. The action of the movable parts is as follows: The guard-lever, *a*, is set free and thrown forward by the right hand. The first part of this movement draws the firing-pin, *b*, from the head of the cartridge, and releases the magazine-gate, *c*, causing it to hold back and stop the cartridge which follows that which has already entered the carrier. As the movement of the guard progresses, the bolt, *d*, is drawn to the rear, ejecting the empty shell, cocking the hammer, *e*, and raising the carrier, *f*, so that when the movement forward is finished, the cartridge in the carrier is in line with the chamber of the rifle, and just in its rear. Reversing the movement of the guard-lever pushes the bolt forward, drives the cartridge into the chamber, and throws the carrier down into position, so that it receives another cartridge just as the reverse motion is completed. The bolt is brought clear forward, and the extractor hooked over the cartridge-head before the magazine-gate, *c*, is released, thus preventing the blocking of the breech-action. This feature is peculiar to this rifle. The firing-pin is held back positively until the cartridge has entered the chamber and the bolt is locked, preventing the possibility of premature explosion. The carrier has at its rear two notches, *g*, with a spring arranged to hold it in one of two positions. If the lever be brought forward, and the carrier be raised without a cartridge, the spring will drop into the forward notch of the carrier and hold it in position; then if a cartridge be dropped on the carrier from the top, a slight pressure on it will drop the carrier to the rear notch, leaving the cartridge in the proper position for entering the chamber by the action of the guard-lever. This arrangement enables the rifle to be used as a single breech-loader when the magazine is empty. The firing-pin lever, *h*, throws the firing-pin back by the first motion of the guard-lever, and holds it back until the completion of the loading. The ejector, *i*, throws out the empty shell as soon as it has been extracted from the chamber. The ejector works by the action of the V-spring contained in the lug of the bolt. There is a cleaning-rod in the stock of the rifle, which can be taken out by opening the cover in the butt-plate. See *Magazine-gun.*



Colt Magazine-rifle.

COLT REVOLVER.—This widely known revolver differs from others in the following points, viz.: The hand, or finger, or pawl which revolves the cylinder has two points, one above the other. The upper engages the ratchet of the cylinder when the revolution begins. But before the necessary sixth of a revolution could be made, as the pawl moves in a plane, and the ratchet-tooth in the arc of a circle whose plane is quite perpendicular to the pawl's plane of motion, the pawl would lose its hold on the tooth, and the revolution of the cylinder would stop. To prevent this the second point is added, and just as the first point will disengage from the ratchet, the second or lower point engages another tooth of the ratchet and completes the revolution. By this arrangement the pawl actuates a larger ratchet than it could otherwise, and therefore exerts more force upon the cylinder, by acting upon a longer lever-arm. This permits a smaller-sized cylinder for the same diameter of ratchet. The cylinder has a bushing which projects in front of it, and gives three surfaces upon which the cylinder revolves, thus diminishing the chance of sticking from dirt or rust, and also giving a very small axis upon which to revolve, decreasing the moment of friction. When the ejector is used it springs back to its place and is ready for use again, avoiding the necessity of putting it back.

To take the arm apart, half-cock the pistol, loosen the catch-screw which holds the center-pin, draw out the center-pin, open the gate, and the cylinder can then be withdrawn. To remove the ejector, turn out the ejector tube-screw, then push the front end away from the barrel and pull it towards the muzzle. The barrel can then be unscrewed. The stock can be removed by turning out the two screws just behind the hammer, and that at the bottom of the strap. All the parts of the lock are then displayed, and can be readily separated. The cylinder bushing should be pushed out for cleaning. To remove the gate, turn out a screw in the lower side of the frame (hidden by the trigger-guard), then the gate-spring and catch can gate, cock and fire it (taking it in the right hand), or bring the hammer to the safety-notch as may be desired. *To Eject the Cartridge-shells.*—1st motion: Holding the pistol in the left hand, half-cock with the right

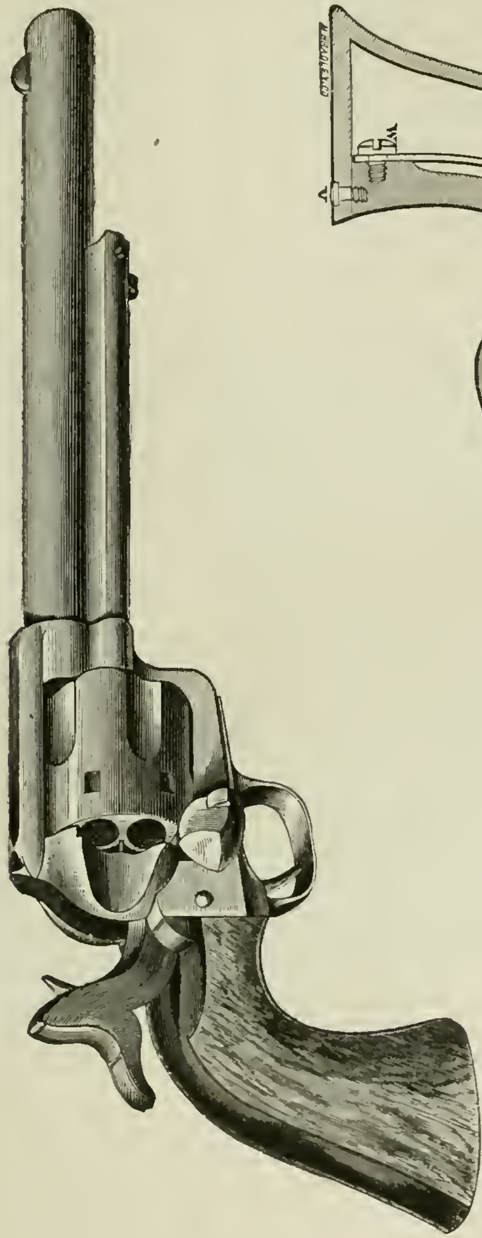


Fig. 1.

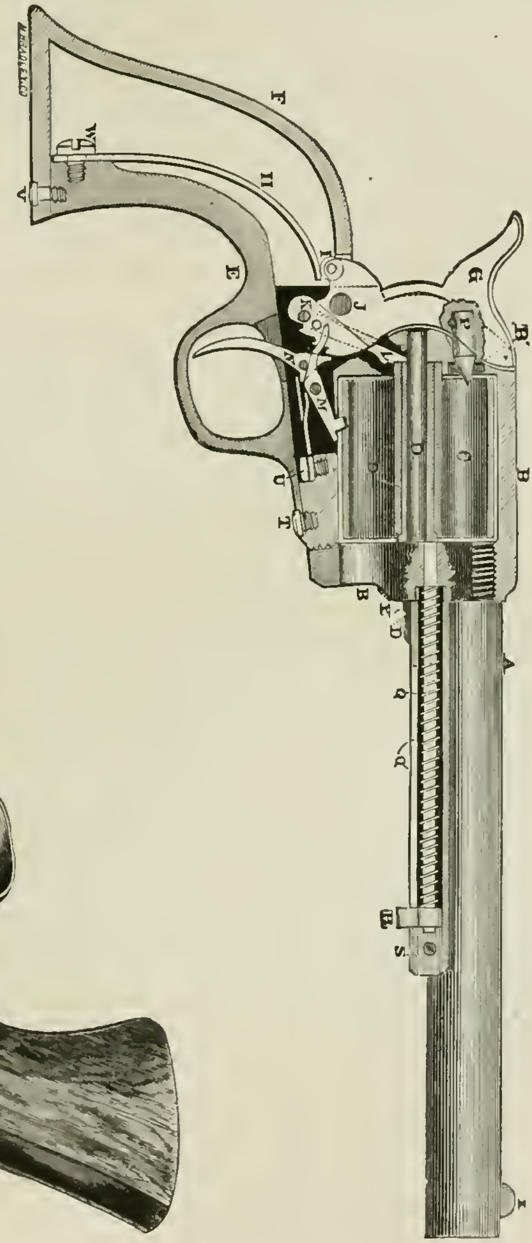


Fig. 2.

Nomenclature.

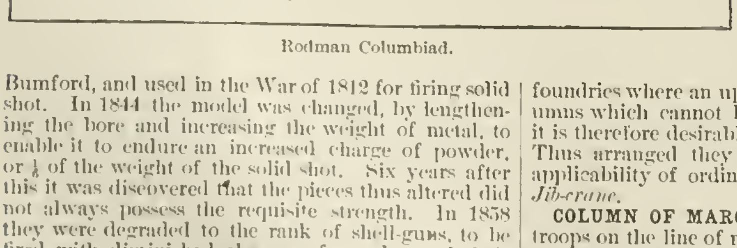
A. Barrel.	G. Hammer.	N. Trigger and screw.	T. Short-guard screw.
B. Frame.	H. Main-spring.	O. Hammer-notches.	U. Sear and bolt (combined) spring and screw.
B'. Recoil-plate.	I. Hammer-roll and rivet.	P. Firing-pin and rivet.	V. Back-strap screw.
C. Cylinder.	J. Hammer-screw.	Q. Ejector-rod and spring.	W. Main-spring-screw.
D. Base-pin.	K. Hammer-cam.	Q'. Ejector-tube.	X. Front sight.
E. Guard.	L. Hand and spring.	R. Ejector-head.	Y. Base-pin catch-screw.
F. Back-strap.	M. Bolt and screw.	S. Ejector-tube screw.	

be withdrawn, and the gate can be pushed out. The best sperm-oil should be used for oiling the parts. *To Load the Pistol.*—1st motion: Holding the pistol in the left hand, muzzle downwards, half-cock it with the right hand and open the gate. 2d motion: Insert the cartridges in succession with the right hand, close the hand and open the gate. 2d motion: Eject the shells in succession with the ejector pushed by the right hand, moving the cylinder with the thumb and forefinger of the left hand. When the shells have been ejected, the pistol is ready for the 2d motion of loading. There are three notches in the hammer of this pistol.

The first is the safety-notch, the second is the half-cock-notch, and the third is the cock-notch. The pistol cannot be fired when the hammer rests in the safety-notch or half-cock-notch, and can be fired by pulling the trigger when the hammer rests in the cock-notch. The pistol should be carried habitually with the hammer resting in the safety-notch.

The drawings are vertical projections of this arm (one-half size). Fig. 2 shows the arrangement of the working parts, and is referred to in the nomenclature. The two back-strap screws just behind the hammer, the stock, the long-guard screw, gate, gate-catch screw, gate-spring, and gate-catch are not shown in Fig. 2. The gate is shown in Fig. 1. The operation of the parts is very simple. As the hammer is cocked, the hand, which is pivoted to its lower portion, rises and engages the ratchet on the base of the cylinder, and causes it to revolve. The lower point or finger of the hand engages with one of the teeth of the ratchet just as the revolution of the cylinder has carried away the preceding tooth from the upper finger of the hand. This completes and insures the revolution by increasing the effective leverage of the hand. The bolt M engages the stop-notches in the surface of the cylinder, to prevent the momentum of the cylinder from carrying it past the firing-point. It is caused to disengage from them by the action of the hammer-cam K, which, rising during the cocking of the hammer, presses up the rear end of the bolt and liberates its front end from the notch. When the revolution is about complete the beveled lower surface of the hammer-cam comes opposite the point of contact on the bolt. At this moment the tail of the bolt (being slit so as to have a lateral spring, and the head being pressed upward by the flat spring U) slides down over the inclined surface of the cam, and the head engages with the stop-notch in the cylinder. The spring U is slit and bent so as to act upon both the bolt and the trigger. The bushing around the base-pin is useful by affording another surface for the revolution of the cylinder, and thereby diminishes the chances of sticking from dirt or rust. Both the cylinder and bushing may revolve on the base-pin, which in turn may revolve in its own bearings.

COLUMBIADS.—A species of sea-coast cannon which combine certain qualities of the gun, howitzer, and mortar; in other words, they are long, chambered pieces, capable of projecting solid shot and shells, with heavy charges of powder, at high angles of elevation, and are, therefore, equally suited to the defense of narrow channels and distant roadsteads. The columbiad was invented by the late Colonel Bumford, and used in the War of 1812 for firing solid shot. In 1844 the model was changed, by lengthening the bore and increasing the weight of metal, to enable it to endure an increased charge of powder, or ⅙ of the weight of the solid shot. Six years after this it was discovered that the pieces thus altered did not always possess the requisite strength. In 1858 they were degraded to the rank of shell-guns, to be fired with diminished charges of powder, and their places supplied with pieces of improved model. The changes made in forming the new model consisted in giving greater thickness of metal in the prolongation of the axis of the bore, which was done by diminishing the length of the bore itself; in substituting a hemispherical bottom to the bore, and removing the cylindrical chamber; in removing the swell of the muzzle and base-ring; and in rounding off the corner of the breech. From the fact that all the trial-pieces have successfully endured very severe tests, it is to be inferred that the defects of the previous model arose from the presence of a cylindrical chamber, and a deficiency of metal in the prolongation of the bore. In 1860 the model proposed by Captain Rodman was adopted for all sea-coast cannon. This model is shown in the drawing; it does not differ, however, in its essential particulars from the model of 1858. See *Sea-coast Artillery*.



Rodman Columbiad.

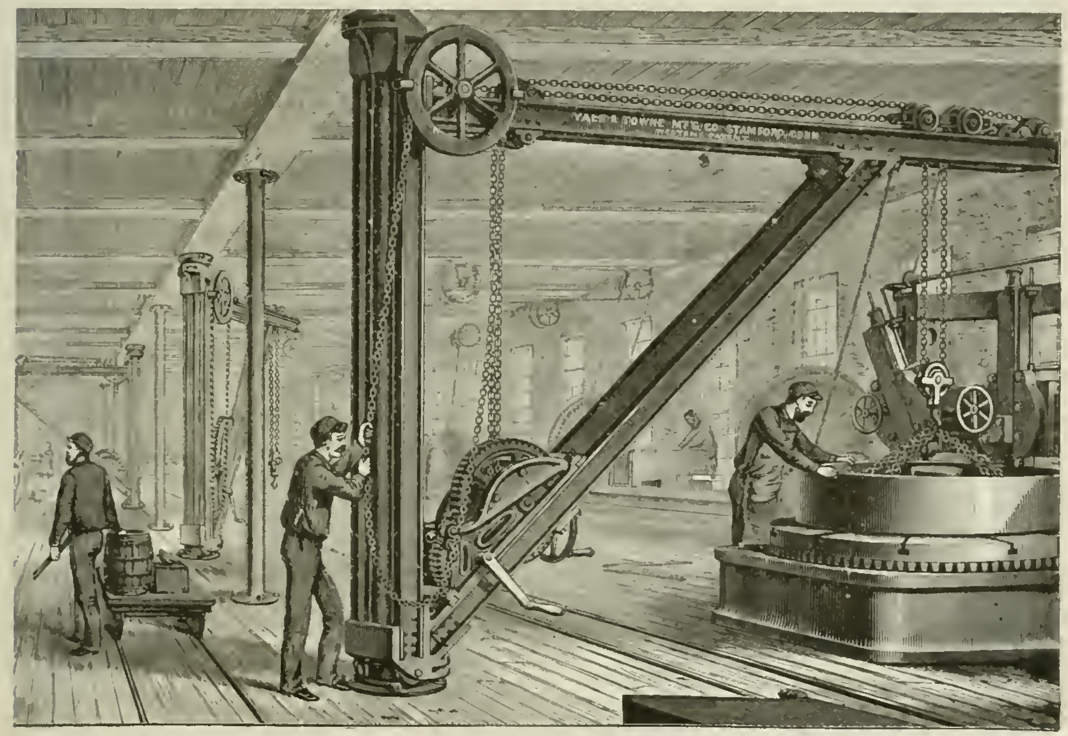
COLUMN.—In military evolutions, a mass of soldiers several ranks in depth, presenting a formation different from that which arises from spreading them out *in line*. There may be columns of brigades, of regiments, of battalions, or of companies; presenting a front of limited width, but a depth depending on the number of elements in the column. If a battalion consists of ten companies, then a "battalion in column" has all the companies posted one behind another. According to the density of the column it is called *open* or *close*. In a battalion, when the distance between any one company and the one immediately before it is such as to admit of their wheeling into line, the formation is called *open column;* when the distance between the front rank of one company and the rear rank of the one before it is only a few yards, it is *close column;* when intermediate between these two, it is *half-distance column*. The relative advantages of column and *line*, in drawing up troops for action, are among the matters closely studied by the commanders of armies: the French, as a general rule, have rather favored the formation in column; the English, that in line. Sometimes the name *column* is given to that which, in effect, is a small army.

COLUMN-CRANE.—Essentially a jib-crane arranged to revolve around a fixed center-column within the mast, the column being utilized for supporting the floor above. This type of crane is built of any desired capacity from 1 ton to 10 tons, although for capacities above 5 tons it is best if possible to arrange the cranes independently of the supporting columns. As seen in the engraving on the opposite page, the mast consists of two wrought-iron channel-beams securely fitted to heavy castings at top and bottom, each of which latter contains horizontal rollers, traveling upon turned paths on the center column, the lower or foot casting being provided also with vertical rollers, traveling upon a circular path around the foot of the column. The vertical rollers carry the weight of the crane and load, while the horizontal thrust at top and bottom is received upon the horizontal rollers. Thus arranged, the rotation of the crane is as smooth and easy as that of a crane turning upon pintles in the usual way. All of the other details of this crane are similar to those of the jib-crane.

This type of crane is designed especially for use in foundries where an upper floor is supported upon columns which cannot be removed, and around which it is therefore desirable that the cranes should rotate. Thus arranged they have all the convenience and applicability of ordinary jib-cranes. See *Cranes* and *Jib-crane*.

COLUMN OF MARCH.—A formation assumed by troops on the line of march, which is governed partly by tactical considerations, partly by arrangements for supply, etc. This formation consists first of an advanced-guard, which is purely *tactical*. At the head of the column, or with the advanced-guard, come the sappers to clear the roads, to repair bridges, and generally to facilitate the march of the column. Next comes the first brigade of infantry, with intrenching tools, for throwing up covering works, if needed. Its ambulance-wagons are kept in the rear, or should be so, and are not allowed to be under fire. All transport of sick from the field of battle should be carried out by stretchers. The position of artillery with such a force should be regulated by tactical considerations. If not required it should be in rear of the infantry, but if wanted should be in rear of the first battalion, or first brigade, sometimes between brigades. Artillery, if between infantry, must conform *exactly* to the pace of infantry, which is very fatiguing and trying to the horses; if in rear, they can make longer halts and vary pace. Mounted corps, when practicable, should march at later hours than dismounted men; if the column comes unexpectedly on the enemy, it is easier to trot artillery past infantry than to hurry up infantry past artillery. The same principles which are applied to artillery may be also to cavalry, and such of it as is not with the advanced-guard is generally in rear of all the force. It is desirable, if not imperative, that artillery and cavalry should not have to conform to infantry pace. See *Marches*.

COLUMN-SHAPER.—A machine much used in armories for die-work, and in a large proportion of cases a substitute for the more expensive shaping-machine. It is employed in various sizes for different work. The 6-inch machine has a stroke 6 inches, adjustable to any less distance; traverse of table 8 inches. Cutter-slide has a quick return, and the cross-feed is automatic and adjustable. The vertical adjustment of the table is 3 inches, and the extreme distance between the top of the table and the under side of the cutter slide is 6 inches. A hand-wheel attached to the cone-shaft permits the machine to be run by hand in an emergency. Weight, including vise and countershaft, 600 pounds. Speed of countershaft, having 8 by 2¼ inches tight and loose pulleys, 180 revolutions per minute.



Column-crane.

The 10-inch machine stands on a hollow column, the base of which measures 36 by 27 inches. The stroke may be graduated to any point within its extreme limit. The cutter slide has a quick return, and the cross-feed is automatic and adjustable. Extreme length of stroke, 10 inches; traverse of table, 16 inches; distance between table-top and bottom of slide, 11½ inches. Weight, including countershaft and vise, 1750 pounds. Speed of countershaft, having 12 by 3 inches tight and loose pulleys, 120 revolutions per minute.

The 24-inch machine designed for very heavy work, by the Pond Machine Tool Company, United States, has a stroke of 24 inches, automatic cross-feed of 21 inches. The table can be lowered to admit of a piece being planed 16 inches high. This table is provided with an angle-plate on one side, with a V-shaped slot to admit of a round piece being planed upon its end. Has a quick return on the back stroke, and a cone-pulley with two changes for cast-iron or steel. Weight, 2000 pounds. Speed of countershaft, 150 revolutions a minute. See *Shaping-machine*.

COMBAT.—An engagement of no great importance or magnitude, or one in which the parties engaged are not armies. See *Single Combat*.

COMBINED MARCHES.—When the movements of divisions and corps are made independent of each other, but having the same object in common, they are known as *combined marches*. They are arranged with the intention of having the several columns arrive at a given position, but coming from different directions. It would be a great risk to select the point of concentration within an area controlled by the enemy, and a plan made with this intention would be faulty. Each column, until it came within supporting distance of the others, would be a detached force and exposed to the dangers of being overwhelmed before support could reach it. Military writers, as a rule, condemn the independent action of detachmets, either to effect a diversion or make a combined march. See *Concentration-marches* and *Marches*.

COMBINED METALS.—The term "built-up" is applied to those cannon in which the principal parts are formed separately and then united together in a peculiar manner. The object of this mode of manufacture is to correct the defects of one material by introducing another of opposite qualities. As for instance: trials have been made to increase the hardness, and therefore endurance, of bronze cannon, by casting them around a core of steel, which formed the surface of the bore. Built-up cannon are not necessarily composed of more than one kind of metal; some of the most noted are made of steel, or wrought-iron alone. In this case, the defects which we have seen to accompany the working of large masses of wrought-iron, viz., crystalline structure, false welds, cracks, etc., are obviated, by first forming them in small masses, as rings, tubes, etc., of good quality, and then uniting them separately. The mode of uniting a built gun may be by welding the parts, by shrinking or forcing one over the other, or by screwing them together. It has been shown by Barlow's law that all parts of the sides of a cannon are not strained equally and are therefore not brought to the breaking point at the same time. Any arrangement of the parts by which the explosive strain is distributed equally over the entire thickness of the piece necessarily brings a greater amount of resistance into play to prevent rupture.

There are two general plans for accomplishing this, viz.: First, by producing a strain of compression on the metal nearest the surface of the bore. This is termed an "initial strain," and is brought about by shrinking heated bands or tubes around the part to be compressed, or by slipping a tube into the bore, which has been slightly enlarged by heat. In either case it is apparent that the extent of the strain depends on the relative size of the fitting surfaces and the amount of heat used to produce expansion. Owing to the difficulty of regulating the heat, it is preferred by some to force the parts together by hydraulic pressure after they have been carefully bored and turned to the proper size. The second plan is based on "varying elasticity," and is accomplished by placing that metal which stretches most within its elastic limit around the surface of the bore, so that by its enlargement the explosive strain is transmitted to the outer parts. By the selection of suitable materials and their proper management, both of these plans may be combined in the same gun, and thereby give it increased strength. See *Cannon-metals.*

COMBLAIN RIFLE.—A breech-loading arm resembling the Sharp rifle. The mountings, receiver, and breech-block of this arm are made of phosphorus-bronze; the barrel is made of steel. The militia of Belgium are armed with the Comblain rifle, while the regular troops have the Albini-Brändlin gun, which has a breech-block operating like that of the Springfield rifle. See *Albini-Brändlin Gun* and *Small-arms.*

COMBUSTION.—The term applied to the process of burning, which usually consists in the oxygen of the air uniting with the constituents of the combustible substance. Thus, the combustion of coal is due to the oxygen of the air passing into a state of chemical union with the carbon and the hydrogen of the coal, forming carbonic acid (CO_2) and water-vapor (HO). Such chemical combinations are always accompanied by the production of more or less heat, as in the case of decaying wood and other vegetable matter; but it is only when the action is so rapid as to evolve intense heat accompanied by light that the process is called burning or combustion. Though the gaseous oxygen has as much to do with the process as the more solid material, coal, wood, paper, or cloth, yet the latter is alone styled the *combustible* or *burning body*, whilst the oxygen is invariably named the *supporter* of combustion. A few substances burn at ordinary temperatures, such as phosphorus, which glows when exposed to the air; but the generality of substances, such as wood, coal, etc., require to be raised in temperature or be set fire to before they possess the power of combining with the oxygen of the air. The amount of heat given out by the various combustibles when burned is capable of being measured, and is definite. The same weight of the same combustible invariably evolves the same amount of heat during its complete combustion; but different combustible substances give off different amounts of heat. The mode in which the heat evolved may be measured is either; (1) to observe the quantity of ice which a given weight of the combustible will melt when burning; (2) to notice the weight of water which the combustible will convert into steam; or (3) to estimate the number of pounds of water which the burning body will raise from 32° to 212° F. The last plan is the more easily managed and accurate. The amount of heat evolved appears, however, to be proportional to the quantity of oxygen required to burn the various combustibles. Thus, when a similar volume of oxygen gas, or even ordinary air, is allowed to flow against the various combustible substances, the following results are obtained:

One pound of Oxygen combined with	Raises from 32 to 212 degrees F.
Hydrogen	29½ lbs. of water.
Charcoal	29 "
Ether	28 "
Alcohol	28½ "

While the absolute amount of heat evolved during the combustion of any burning body is the same, yet the sensible heat may vary according to the rapidity of the process. Thus, when phosphorus is exposed to the air at ordinary temperatures, it very slowly combines with oxygen, and gives out little heat at any one moment, but it is diffused over a great length of time; whilst if the phosphorus is set fire to in the air, it burns vividly, and gives out much heat and light for a short time; and still further, if the burning phosphorus be placed in pure oxygen, it enters into most vivid combustion, and evolves a most intense heat and brilliant light for a still shorter time. In the latter instances, the heat evolved at any one moment is greater, because more rapid, than that given off at the same time during the slower process of combustion; but when allowed to proceed to a termination, there is as much heat produced during the whole time occupied in its development. The same remark applies to the coal placed in a furnace. So long as the door of a furnace is open, and there is little draught of air through the fuel, a moderate amount of heat is evolved, which may last for several hours; but when the door is shut, and much air is drawn through the coal, the latter is more quickly burned, and more heat is evolved during a shorter period of time than before, but in the long-run there is the same amount of heat evolved.

Temperature and atmospheric pressure considerably influence the products obtained from burning gunpowder. When exposed in the open air to a temperature gradually increasing to 572 degrees Fahrenheit, the sulphur sublimes, taking with it a portion of the carbon. This was shown by Saluces, who passed the volatilized products through a screen of very fine cloth, and found carbon deposited on it. Powder may be, therefore, completely decomposed by a gradual heat, without explosion; but when suddenly brought in contact with an ignited body, the temperature of which is at least 572 degrees Fahrenheit, the sulphur has not time to sublime before explosion takes place. The proportions for war-powder for the United States service are seventy-six parts of niter, ten of sulphur, and fourteen of carbon. By the atomic theory the proportions should be 74.64 niter, 11.85 sulphur, 13.51 carbon. If we adopt these last proportions, the formula for gunpowder becomes

$$(NO_5 + KO) + S + 3C.$$

If we suppose the ingredients to be pure, and to arrange themselves under the influence of heat according to their strongest affinities, there will result one equivalent of nitrogen, three of carbonic acid, and one of sulphide of potassium, for

$$(NO_5 + KO) + S + 3C = N + 3CO_2 + SK.$$

The products are, therefore, either solid or gaseous. Usually, powder contains a slight quantity of moisture; the ingredients are not absolutely pure, nor are they proportioned strictly according to their combining equivalents; it might be expected, therefore, that the actual would differ from the theoretical results. The actual gaseous products obtained by combustion are principally *nitrogen* and *carbonic acid*, sometimes *carbonic oxide*, a little *sulphuretted hydrogen*, *carburetted hydrogen*, and *nitrous oxide*. The solid products are *sulphide of potassium*, *sulphate of potassa*, *carbonate of potassa* (mingled with a little *carbon*), and traces of *sulphur*. When the sulphide of potassium comes in contact with the air, it is converted into sulphate of potassa, and gives rise to the white smoke which follows the explosion of gunpowder. A portion of the sulphide is sometimes condensed on the surface of the projectile, which accounts for the red appearance of shells sometimes observed in mortar-firing. The solid products are probably volatilized at the moment of explosion by the high temperature which accompanies the combustion; but, coming in contact with bodies of much lower temperature, they are immediately condensed. In chambered arms,

Density of products of combustion	No. of volumes of expansion.	Total Work that the Gunpowder is capable of Realizing.	
		Per kilogramme burned, in kilogrammeters.	Per pound burned, in foot-tons.
.95	1.0526	3210.8	4.70
.90	1.1111	6339.6	9.29
.85	1.1768	9412.8	13.79
.80	1.2500	12443.3	18.23
.75	1.3333	15460.8	22.65
.70	1.4286	18488.1	27.08
.65	1.5385	21544.9	31.56
.60	1.6667	24650.8	36.11
.55	1.8182	27841.9	40.78
.50	2.0000	31153.7	45.62
.45	2.2222	34614 0	50.70
.40	2 5000	38290.0	56.08
.35	2.8571	42234.7	61.86
.30	3.3333	46565.9	68.21
.25	4.0000	51414.8	75.31
.20	5.0000	57031.7	83.53
.17	5.8824	60952.1	89.35
.16	6.2500	62368.1	91.45
.15	6.6667	63884.4	93.64
.14	7.1429	65470.1	95.94
.13	7.6923	67138.4	98.39
.12	8.3333	68940.1	101.00
.11	9.0909	70855.4	103 82
.10	10.0000	72903.7	106.87
.9	11.1111	75214.5	110.18
.8	12.5000	77679 9	113 81
.7	14.2857	80462.1	117.85
.6	16.6667	83582.1	122.42
.5	20.0000	87244.4	127.79

small drops of sulphur may be observed condensed on the sides of the bore, which show that the sulphur has been volatilized; and we know that good powder burns on paper and leaves no trace. This fact, however, was most completely shown by the experiments of Count Rumford. This celebrated observer used a small eprouvette of great strength, which he partially filled with powder, and hermetically closed with a heavy weight. The powder was fired by heating a portion of the eprouvette to redness. Whenever the force was sufficient to raise the weight, the entire products escaped; when it was not, a solid substance was found condensed on the surface of the bore furthest from the source of heat.

The late researches of Captain Noble and Mr. Abel on fired gunpowder have resulted in certain important conclusions. From them it appears that the permanent products of fired gunpowder are only 43 per cent of gas and 57 per cent of matter, which ultimately assumes a solid form. The temperature of the explosion is about 4000 degrees Fahrenheit, and though much of the heat is spent in performing the work of moving the shot or conducted away by the metal, so that the expanded gases would contract and lose a great deal of their power, the matter which will ultimately be solid but is at the moment of explosion fluid, by reason of the great heat, gives up much of its heat when coming to the solid form, and thus keeps up the temperature of the gases, causing them to retain their high expansion. These gases, if allowed to cool down to a freezing temperature, would occupy about 280 times the bulk of the powder they sprang from. The tension of the products of combustion, when the powder entirely fills the space in which it is fired, is about 6400 atmospheres, or about 42 tons per square inch. Therefore, if no air-space be left and the shot be delayed until the powder is entirely consumed, there will be a pressure everywhere within the powder-chamber of 42 tons in each square inch of the interior. From the results of their experiments they formed the foregoing table, which shows the greatest amount of work in projecting a shot that can be obtained per pound of powder from a charge in any gun. When the charge is fired, it begins to push the shot forward. If the gun is very short, so that the shot can escape from the pressure at once, the velocity given to it will be small. Thus, within practical limits, the longer a projectile is kept under the influence of the fired charge, the greater will be the velocity. This subject will be further considered under other headings. See *Explosion*, *Gunpowder*, and *Velocity of Combustion*.

COMES.—An officer among the Romans, with territorial jurisdiction in the provinces, and especially on the frontiers.

COMIGNE.—A shell of extreme magnitude, which takes its name from the person who originally invented it.

COMMAND.—1. A body of troops, or any military force or post, under the command of an officer.

2. The height of the interior crest above the site is the *command* of the work. The term is also used to express the height of the interior crest of one work above that of another, or above any particular point within range.

3. An officer may be said to command at a separate post when he is out of the reach of the orders of the Commander-in-Chief, or of a Superior Officer, in command of the neighborhood. He must then issue the necessary orders to the troops under his command, it being impossible to receive them from a Superior Officer. If, upon marches, guards, or in quarters, different corps of the army happen to join or do duty together, the officer highest in rank of the Line of the army, Marine Corps, or Militia, by commission, there on duty or in quarters, commands the whole, and gives orders for what is needful to the service, unless otherwise specially directed by the President, according to the nature of the case. In all matters relating to the rank, duties, and rights of officers, the same rules and regulations apply to officers of the regular army and to volunteers commissioned in or mustered into said service, under the laws of the United States, for a limited period. Officers of the militia of the several States, when called into the service of the United States, shall on all detachments, Courts-Martial, and other duty wherein they may be employed in conjunction with the regular or volunteer forces of the United States, take rank next after all officers of the like grade in said regular or volunteer forces, notwithstanding the commissions of such militia officers may be older than the commissions of the said officers of the regular or volunteer forces of the United States. The Acts of Congress giving rank to officers of the Medical and Pay Departments of the army provide that they shall not, in virtue of such rank, be entitled to command in the Line or other Staff Departments of the army; and so, if any other legal restrictions on rank exist, they must be found in some

positive statute. This necessity is made plain by the consideration that *military rank means a range of military subordination.* Higher rank, therefore, created by law cannot be made subordinate to lower rank, except by positive law; or, in other words, a junior cannot command a senior, unless the law shall otherwise decree. The 122d Article of War is ambiguous, from the use of the words "Line of the Army;" our legislation having applied those words to contradistinguish Regular Troops from Militia, and also, in many cases, the same words are correlative and contradistinctive of Staff of the Army. "But," says President Fillmore, after a careful examination on his part, to determine the question, "I find but one Act of Congress in which the words 'Line of the Army' have been employed to designate the Regular Army in contradistinction to the Militia, and none in which they have manifestly been used as contradistinctive of brevet." Whatever ambiguity, therefore, may exist under the 122d Article, in respect to the right of command on the part of officers of Staff Corps and Departments, the article does not decree any restriction on brevet rank; and hence the great principle that rank on duty confers military command has its full force in respect to commissions by brevet, and all other commissions not restricted by law. The President, as Commander-in-Chief under the 122d Article of War, may relieve any officer from duty with a particular command, or he may assign some officer of superior rank to duty with a command; but the laws have not authorized him to place a junior in command of a senior, and that power which creates rank, viz., Congress, is alone authorized to place restrictions on its meaning. See *Rank*.

COMMANDANT.—In military matters, a temporary Commander, in place of the real Chief; such as a Captain Commandant, Lieutenant Commandant, etc. In foreign armies the designation is more frequently applied than in the British, especially to the Commanders of Garrisons.

COMMANDANT OF CADETS.—The Commandant of Cadets, appointed by the President, has the immediate command of the battalion of Cadets at the U. S. Military Academy. He is also the Instructor in the Tactics of the three arms of the service, and in the rules of Military Police, Discipline, and Administration. For instruction in infantry tactics and military police and discipline the Cadets are organized into a battalion of four companies, under the Commandant of Cadets, and assigned to quarters accordingly; each company being under the command of an officer of the army, designated as Assistant Instructor of Tactics. The officers and non-commissioned officers are appointed by the Superintendent, from a list submitted by the Commandant of Cadets. This selection is made from those Cadets who have been most studious, soldier-like in the performance of their duties, and most exemplary in their general deportment. In general, the Officers are taken from the first class, the Sergeants from the first and second classes, and the Corporals from the second and third classes. The Commandant of Cadets is charged with the command of the battalion, and with the instruction of Cadets in all the rules of military police, discipline, and administration. He is assisted in these duties by the four Assistant Instructors of Tactics, who are quartered in the Cadet Barracks during the academic year. During the encampment the Commandant and these four Assistants are quartered in camp.

COMMANDER-IN-CHIEF.—The President, by the Constitution, is "Commander-in-Chief of the army and navy of the United States, and of the militia of the several States, when called into the actual service of the United States." Under the same authority he nominates, and by and with the advice and consent of the Senate appoints, and commissions all commissioned officers of the regular army. In the British army the Commander-in-Chief is the highest Staff appointment. It is held by the General commanding all the forces in India, and would probably be given to the leader of any *large* army in the field, whether abroad or at home. Formerly the army at home was administered by an officer of this rank; but since the death of the Duke of Wellington, in 1852, the military administration has vested in an officer holding no higher commission than that of "General on the Staff;" who is called the General (or Field-Marshal, according to the holder's army rank) Commanding-in-Chief. Since 1855 this officer has been strictly subordinate to the Secretary of State for War. The office of the Commander-in-Chief, technically known as the "Horse-guards," is a Department of the War Office, and comprises the sub-departments of the Military Secretary, the Adjutant General, and the Quartermaster General, with a staff of clerks. Under the "War-Office Act" of 1870, and by Orders in Council of that year, the officer Commanding-in-Chief is one of the three great officers who administer the military affairs of the country under the Secretary of State for War; his department being that of military command, discipline, and promotion. In practice he makes all promotions and military appointments, though in theory these are all made on the responsibility of the Secretary of State. Appointments to very important positions on the Staff would not be made without the supervision of the Minister and probable concurrence of the Cabinet. The officer Commanding-in-Chief is responsible for all recruiting operations, and for the appropriation of troops to particular localities; but he exercises rather a general inspectional control than any immediate command over the men. The actual command vests in the General Officers commanding the districts into which the Kingdom is parceled.

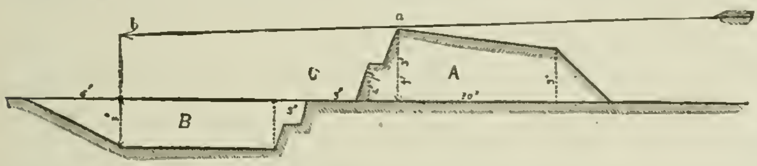
COMMANDER-IN-CHIEF'S DEPARTMENT.—A department of the British army which consists of the Adjutant General and Quartermaster General, nominally amalgamated, but working apart. The following branches, at the Horse-guards, are called divisions, and are thus told off: Military Secretary; Intelligence; Auxiliary Forces; Military Education. Adjutant General and Quartermaster General are ordinary combatants, to whom are intrusted respectively the departments of—Adjutant-General: Recruiting, Discharges, Discipline, Inspections. Quartermaster General: Returns, Movement of Troops, Intelligence. To the Military Secretary's Department are intrusted First Appointments, Promotion, Rewards, Staff Appointments, and Exchanges. The above is the distribution of the Staff at the Horse-guards, and these divisions are adhered to in the smaller fractions as closely as possible.

COMMANDERY.—The title of the meeting or meeting-place of Freemasons who have reached the degree of Knights Templar. Its origin was with the Knights of Malta of the Middle Ages, and was first applied to sums saved from the revenues of the Order for the support of war against the Moslems. It soon came to mean persons and places rather than things, and the "Grand Commander" became the next office to the Grand Master. Among the religious establishments suppressed in England by Henry VIII. were more than fifty Commanderies of Knights Templars.

COMMAND OF FIRE.—An expression for the difference of command of two works situated on the same horizontal ground.

COMMAND OF OBSERVATION.—When the command of the parapet is only sufficient to permit the defenders of a work to look over the parapet of another work it is named *command of observation.*

COMMAND OF PARAPET.—In horizontal sites the parade may be taken either on the natural surface or below it. In inclosed works it should always be on the natural surface to keep the parade dry. In lines, particularly if of great extent and thrown up merely to receive battle or for a short occupancy, the parade may consist of a shallow trench behind the parapet which is formed of the earth taken from the trench. The general form of the parapet is the same in both cases. Its dimensions will vary with the kind of soil used in its construction; with the time and means that can be employed; with the time that the work is to remain occupied; and, finally, with the time and means that the enemy can dispose of in the attack, and the degree of resistance that the work should offer. The command of the interior crest should be so regulated as to intercept the enemy's missiles and to shelter the assailed. Men of the greatest ordinary stature, in bringing their muskets to an aim, do not fire at a higher level than about five feet; therefore any mass of this height in front of them will just intercept their fire; but this mass would not shelter a man standing behind it; to effect this, in the case of the tallest men usually found in the ranks, the interior crest should be at least six feet six inches above the terre-plein. The command must then be regulated by these two facts, and this principle may be laid down: *The command of a field-work over the ground occupied by the assailant should be at least five feet; and six feet six inches over that occupied by the assailed.* In following this rule for the command, we deprive the assailant of a *plunging* fire upon the parade; but as a breast-height of five feet is too high for men of ordinary stature to fire over it and give their pieces any sensible depression, it would be necessary to throw up a banquette for this purpose behind the parapet, which would add to the time and labor of constructing the work. On this account it is best to give the parapet only the height to admit effective firing over it, which is about four and a quarter feet. In the drawing, which represents a profile of this height, the plunge of a man standing



A, Parapet; B, Trench; C, Banquette-tread.

at sixty feet in advance of the parapet would be only three inches below the level of the point *a*, at the point *b*, or his bullet would strike seven feet above the point at the rear of the parade, which is the most exposed position for a man to be standing. See *Field-fortification*.

COMMANDS.—There are two kinds of commands in the military service: the *preparatory command*, such as *forward*, which indicates the movement that is to be executed, and the command of *execution*, such as *march* or *halt*, or, in the Manual of Arms, the part of the command which causes the execution. The tone of command is animated, distinct, and of a loudness proportioned to the number of men under instruction. Each preparatory command is pronounced in an ascending tone of voice, but always in such a manner that the command of execution may be more energetic and elevated. On foot the command of execution is pronounced in a tone firm and brief. In mounted movements the preparatory commands are more or less prolonged to insure their being heard; the command of execution is always prolonged. The trumpet is used for giving commands whenever it can be done to advantage.

COMMILITONES.—A word having the same significance with the Romans as the English term *comrade-soldiers*.

COMMISSARIAT.—A name given to the organized system whereby armies are provided with food and daily necessaries other than those connected with actual warfare. Among the ancients the Romans devoted the most attention to the Commissariat; the *Quæstors* were the Commissaries. In feudal times the soldiers were mainly dependent for food on their lords; but they lived very much by plunder. During the wars of the Crusades the Commissariat was so utterly neglected that thousands died of starvation. In England the first germ of the modern Commissariat appeared in the office of *Proviant-master*, in the time of Queen Elizabeth. Under Charles I., Commissaries were stationed in the different Counties. Under Marlborough's command the troops were supplied by contract; he received a percentage, and peculation was very common. After many changes during the eighteenth century a Commissary General was appointed in 1793, to superintend all contracts for food and forage. The dire experience of the Crimean War showed how greatly reform was required in this important Department. In 1858 and 1859, accordingly, it was newly organized; and remained until 1870 a War-Office Department, under a Commissary General-in-Chief. In 1870 the Commissariat was merged with other supply departments in the great "Control Department," which, under the Surveyor General of the Ordnance, performed all the civil administrative duties of the army. In December, 1875, the Control Department fell from its high estate, and the "Commissariat and Transport Department" arose from its ashes. Its duties are the provision of food, fuel, lodging, and transport: a function on which it is needless to say the very existence of the army depends. The Department is administered by the Director of Supplies at the War Office, who is an officer on the Staff of the Surveyor General. In the United States service this Department is under charge of the Commissary General of Subsistence, who has the rank of Brigadier General. See *Subsistence Department*.

COMMISSARIAT DEPARTMENT.—A warrant has been lately issued by which the Control Department of the English army has been abolished; and all its branches except the *Pay Sub-department* have been reclassified and divided into (*a*) the Commissariat and Transport Department, (*b*) the Ordnance Store Department, placed under the direction of the Surveyor General of Ordnance. Its organization is laid down as follows: 1. All officers of the Commissariat and Transport Department and of the Ordnance Store Department shall hold commissions. 2. Officers of these Departments shall be the officers of and shall command the Army Service Corps. 3. The ranks of the officers of the respective Departments shall be as follows: Commissary General, Deputy Commissary General, Assistant Commissary General, Commissary, Deputy Commissary, Assistant Commissary, Sub-assistant Commissary. 4. The relative rank of these officers shall be as follows: Commissary General—with an army in the field, special; otherwise as Major General; Deputy Commissary General, as Colonel; Assistant Commissary General, as Lieutenant Colonel; Commissary, as Major; Deputy Commissary, as Captain; Assistant Commissary, as Lieutenant; Sub-assistant Commissary, as Sub-lieutenant; and such relative rank shall regulate their quarters and military allowances, including pensions for wounds, and pensions and allowances to their wives and families, except in the case of a Sub-assistant Commissary, who for these purposes shall rank as Lieutenant. 5. Appointments to the Commissariat and Transport Department and to the Ordnance Store Department shall be conferred upon such officers, non-commissioned officers, and civilians as may be recommended by the Secretary of State. 6. Candidates shall be subject to such educational examination as the Secretary of State may from time to time determine. 7. Sub-assistant Commissaries shall be liable to be removed from the service for moral or physical unfitness, or if they fail to make satisfactory progress in qualifying themselves for permanent service in the Department. 8. Sub-assistant Commissaries, after two years' satisfactory service as such, may receive commissions as Assistant Commissaries. Those officers who may have been appointed from the army shall resign their commissions as combatant officers upon receiving commissions as Assistant Commissaries. 9. Service as Sub-assistant Commissary shall count towards retirement from the higher ranks of the respective Departments. 10. The periods of service towards retirement specified in Article 17 shall be applicable to officers of the Commissariat and Transport Department or of the Ordnance Store Department, and in the case of officers promoted from the ranks shall include service in all grades, but not less than one half of such periods shall consist of service as a commissioned officer. 11. Officers of the rank of Deputy or Assistant Commissary shall be selected for the appointments of Adjutant and Quartermaster in the Army Service Corps. 12. Combatant officers while under probation may at any time be ordered to return to their regiments. 13. An officer shall be eligible for promotion to the under-mentioned ranks if he shall have served on full pay for the following periods, dating from his first entrance into the service: To the rank of Commissary General, thirteen years, of which at least three shall have been as Deputy Commissary General; to the rank of Deputy Commissary General, ten years, of which at least three (including probationary service) shall have been as Assistant Commissary General. 14. If, during active service, a temporary augmentation of the Commissariat and Transport Department or of the Ordnance Store Department shall become necessary, the General Officer Commanding may grant to Officers of those Departments permission to hold temporarily the higher rank in which they may in such an emergency be called upon to act, or may temporarily appoint Combatant Officers, reporting his proceedings for the approval of the Secretary of State. 15. A Combatant Officer so appointed shall receive the pay and allowances of the departmental rank in which he shall be employed, in lieu of all other emoluments. 16. Officers shall be allowed to count their previous departmental or combatant service as service in the Commissariat and Transport Department or in the Ordnance Store Department. 17. Officers who shall have completed a total full-pay service of thirty years, including previous departmental or combatant service, shall, on giving six months' notice, have an unqualified right to retire on retired pay. It shall, however, be competent to the Secretary of State to place officers on the retired list after a meritorious service of twenty years, including departmental or combatant service, if by reason of mental or bodily infirmity of a permanent nature (to be certified by a Medical Board), contracted in the service, they shall be unfit for further duty; or in case of reduction of establishment, or retirement under the provisions of Articles 18 and 19. 18. The retirement of officers who have attained the rank of Assistant Commissary General, or who are above that rank, shall be compulsory at the age of sixty years. 19. The retirement of officers below the rank of Assistant Commissary General shall be compulsory at the age of fifty-five years.

COMMISSARY.—A name applied to an officer who has charge of the subsistence of troops, musters, etc. The term is applied in general to any one to whom the power and authority of another is committed. In this sense it is nearly equivalent to Commissioner. In ecclesiastical law a Commissary is an officer appointed by a bishop to exercise jurisdiction in parts of the diocese which are so distant from the episcopal city that the people cannot be conveniently summoned to attend the principal Court. When the papal authority, and all jurisdiction which flowed from it, was abolished in Scotland, by the Acts of 1560 and 1567, a supreme Commissary Court was established in Edinburgh, by a grant of Queen Mary, dated February 8, 1563. This Court had jurisdiction in actions of divorce, declarators of marriage, nullity of marriage, and all actions which originally belonged to the bishop's Ecclesiastical Courts. Its powers were gradually conjoined with those of the Court of Session, and it was finally abolished in 1836, the small remains of its once important jurisdiction being united in the Sheriff of Edinburgh. The inferior Commissariats, which had usually been commensurate with the dioceses, were dealt with by a previous statute, each County being erected into a separate Commissariat, of which the Sheriff was Commissary. The jurisdiction of these Courts so conjoined with that of Sheriffs was, in 1876, finally transferred to the Sheriffs absolutely, and the separation between the two sets of officers ended, except in the case of the Commissary Clerk of Edinburgh.

The term was used in the old French service to express a variety of military occupations, as it is in the Control Department of the British service at the present day.

COMMISSARY GENERAL OF PRISONERS.—An officer announced in time of war to superintend the treatment of prisoners, and charged with the enforcing of such regulations as may be necessary for their welfare. He has authority to call for such reports from officers in command of guards over prisoners as may be necessary for the proper discharge of his own duties, and he should be prepared to furnish all information in relation to prisoners called for by the Adjutant General. A full record of all prisoners is kept in the office of the Commissary General of Prisoners, in suitable books, giving the name, rank, regiment, and company of each military prisoner, the residence of each civil prisoner, with the charges against him, and the time and place of capture or arrest. Any special information of importance is added from time to time in the column of remarks. When disposed of by exchange or otherwise, the fact and authority for it, with the time, should be noted on the record. The Commissary General of Prisoners is empowered to visit places at which prisoners may be held, and to recommend to the General whose guards are responsible for them whatever modification in their treatment may seem to him proper or necessary, and report the same to the War Department. See *Prisoners of War*.

COMMISSARY OF MUSTER.—An officer charged with mustering in and mustering out of troops. During the Civil War in the United States this duty was extensively performed by Staff-officers, who were known officially as Commissaries of Musters.

COMMISSARY OF ORDNANCE.—The departmental title given to an officer of English artillery who has charge of an arsenal in India. Each officer, on being appointed to the Ordnance Department, remains on probation until he has passed an examination in the various subjects appertaining to the charge of an arsenal, such as accounts, the nomenclature and use of stores, the working of metals, etc., when, if found qualified, he is posted to the Department. The duties attached to the office of a Commissary of Ordnance will be found in the Ordnance Codes of each Presidency.

COMMISSARY SERGEANTS.—Non-commissioned Staff-officers appointed by the Secretary of War from Sergeants who have faithfully served five years in the Line, three of which shall have been in the grade of non-commissioned officers. Sergeants receiving these appointments are dropped from the rolls of the regiment or company in which they have been serving. Captains report to their Colonels such Sergeants as, by their conduct and service, merit appointments as Commissary Sergeants, setting forth the description and length of service of the Sergeant; the portion of his service he was a non-commissioned officer; his general character as to fidelity and sobriety; his qualifications as a clerk, and his fitness for the duties of the position for which he is recommended. From the nature of the duties assigned to these Sergeants it is evident that their judicious selection is of no small importance to the interests of the service. While the law contemplates in the appointment of Commissary Sergeant the better preservation of public property at the several posts, there is also a further consideration—that of offering a reward to faithful and well-tried Sergeants, and thus giving encouragement to deserving soldiers to hope for substantial promotion. Colonels and Captains cannot be too particular in investigating the characters of the candidates, and in giving their testimony as to their merits. The duty of the Commissary Sergeant is to assist the Commissary in the discharge of all the duties of his office, viz., such as receiving, storing, preserving, transferring, issuing, selling, and accounting for the subsistence supplies at the post, according to the regulations of the Subsistence Department; but the presence of a Commissary Sergeant at a post in no manner relieves the Commissary from the responsibility for, and proper care of, subsistence supplies. At posts where there is no commissioned officer the Commissary Sergeant is responsible for subsistence supplies, and is governed by the Regulations of the Subsistence Department in issuing and accounting for the same.

COMMISSION.—A writing, in the form of a warrant or letter-patent, authorizing one or more persons to perform duties or exercise powers belonging to another, or to others. Instruments of delegation, bearing this title, are issued to Officers in the Army and Navy, Judges, Justices of the Peace, and others. In the British service, commissions, commencing with the Sub-lieutenants of the army, are given to candidates after passing the prescribed examination before the Civil-Service Examiners, when they are sent to Sandhurst College for further instruction, chiefly of a military nature. They are not posted to regiments until they have passed the final examination, except those who are gazetted to regiments in India, which they proceed at once to join. After serving one year with their regiments, they are attached to garrison classes in India, and undergo a course of military instruction required to qualify them for promotion to the rank of Lieutenant. Militia Lieutenants are eligible for commissions in the regular army after serving for two trainings in a militia regiment; on passing the usual examination they are further subjected to such regulations as to age or otherwise as may be issued from time to time by the Secretary of State for War.

COMMISSIONAIRES.—A body of old or disabled soldiers who, on being pensioned, are formed into a Corps, and stationed in London and Edinburgh. They are employed, for the most part, as porters and in positions of trust, such as door-keepers over jewellers' shops. They run also as messengers. They must be men of unexceptionable character to whom these posts and duties are intrusted.

COMMISSIONERS OF ARRAY.—The predecessors of the modern Lords-lieutenant, whose duties consisted, amongst others, of seeing enforced in feudal times the observance of regulations which had for their object the maintenance of able-bodied men in the realm for the protection of the land.

COMMON MINE.—The term *common mine* is applied to a crater when its radius is equal to the line of least resistance. When the crater radius is greater than the line of least resistance, the terms *overcharged mine* and *globe of compression* are used. When the crater radius is less than the line of least resistance, the mine is termed *undercharged*. A small mine with a line of least resistance not greater than nine feet, formed by sinking a shaft from the surface of the ground and placing the charge at the bottom of it, is termed a *fougasse*. The term *camouflet* is applied to small mines used to suffocate the enemy's miners without producing an external explosion.

COMMON TIME.—In marching, the length of the direct step in common time in the United States service is 28 inches, and the cadence is at the rate of 90 steps per minute. The length of step and cadence varies in different services. See *Cadence* and *Step*.

COMMUNICATIONS.—1. In speaking of the communications of an army, common roads, railroads, navigable rivers, canals, and telegraph lines are usually meant, as it is by means of these that the different parts of an army, in its military operations upon land, are connected with each other. The establishment of these communications, and their maintenance, give the General in command of an army great solicitude. So important are they in military operations that they largely influence the General in his selection of the theater of operations, if the choice is left to him. The establishment and maintenance of these communications form a part of the duties ordinarily assigned to the Engineers, and the construction of bridges plays a most important part of this particular duty.

2. The communications form a very important element in the defense of permanent works. The size and disposition of the communications should vary with the character of the work in which they are placed. In small works, which from the size of their garrisons are calculated to make only a strictly passive defense, communications of just sufficient dimensions for the passage of the troops from point to point will serve every purpose, and can be more easily barricaded and otherwise defended. But for large works having full garrisons the communications should be such that sorties of all arms and in large bodies can be quickly made. With communications of this character a besieging force would be constrained to adopt extraordinary measures of safety, keeping large guards in the trenches to secure them from such sorties, to which they would be continually exposed.

All communications, to serve properly their ends, should fulfill the following conditions: 1. They should never, from their position, compromise the safety of the enceinte. Frequent instances could be cited of works which have been surprised by an enemy obtaining possession of the gates. Therefore too many precautions cannot be taken to secure the principal outlet from the body of the place from similar attempts. 2. They should admit of a convenient circulation of the besieged. To subserve this purpose, the dimensions, slopes, etc., of the posterns, ramps, and other similar works should be convenient for the service to which they are applied; and they should be placed in such positions as lead directly to the point to be reached. 3. The position chosen for any communication should be such that when an enemy gets possession of it he may obtain no advantage by it. To be useless to an enemy, the communication, when in his possession, should not offer a shelter for his works, nor enable him to carry them on with more ease. This end will be obtained by placing the communications in a position to be swept by the fire of the works in their rear, and so arranging them as to preserve the counterscarp wall unbroken. 4. The communications should be covered from every point where an enemy might establish himself, during the whole period that they can be of service to the besieged; and they should be swept by the fire of the enceinte. Without these precautions, an enemy might cut off all communication from the enceinte with the outworks; and in case of retreat, the troops could not derive any assistance from the enceinte, if he attempted to press upon them. 5. They should be so placed as not to compromise the retreat of the troops. This is effected by placing the communications in the re-enterings, which are the most secure points, as an enemy to reach them will have to brave a powerful column of flank fire. Barriers, gates, and movable bridges of timber should be placed at suitable points, to cut off one communication from another, and thus arrest the progress of a pursuing enemy. 6. Finally, each work should be independent of every communication except that one destined for its particular use. This is an important object, as it prevents an enemy, should he succeed in gaining possession of a communication leading through it, from seizing upon the work itself. See *Bridges*, *Covered Communication*, *Gateway*, *Postern*, *Ramp*, and *Stairs*.

COMMUTATION OF QUARTERS.—Officers on duty without troops at places where there are no public quarters are entitled to commutation, which is paid by the Pay Department at the rate authorized by law. Commutation of quarters is paid only at the station for which it is claimed, and by the senior disbursing Paymaster thereat, or, if there be no Paymaster at the station, by the Chief Paymaster of the Department, or such of his subordinates as he may designate upon the officer's application. The following officers are entitled to the allowance of quarters, and to purchase fuel at the legal rates, viz.: Officers who, for the convenience of the Government, are directed to await orders for a limited period at a designated station where there are no public quarters until the proper time arrives for giving them specific orders. The following are the present rates of commutation in the United States army: Lieutenant General, $100 per month; for all other grades the rate is $12 per month per room.

COMMUTATION OF RATIONS.—Commutation of rations at thirty cents may be paid to soldiers stationed where the Government does not otherwise provide for their subsistence, on satisfactory evidence that they have not received rations or an equivalent therefor during the period for which commutation is claimed. Commutation may also be paid a soldier traveling under orders on detached command, when it is impracticable to carry his rations, at the rate of one dollar a day, or less, as the Secretary of War may direct. The amount is paid by the Commissary when due, or in advance upon the order of the Commanding Officer, for the necessary number of days' travel. The voucher should show the nature and extent of the duty, and the certificate of a Commissioned Officer or the affidavit of the soldier must be added that it was impracticable for him to carry his rations. It should also be accompanied by the order directing the journey to be made, or a duly authenticated copy thereof. When it is proper that the original order should be retained by the soldier, the amount paid him for commutation should be noted thereon, with time and place of payment, duly signed by the Commissary. Commutation of rations, at the rate of twenty-five cents, is allowed to soldiers on furlough by competent authority. Payment is not made until the expiration of the furlough, or after discharge, if furloughed till then. The furlough must state the date up to which the soldier has been subsisted, and must be presented with the claim for commutation with the certificate of a Commissioned Officer that the soldier had returned to duty at its expiration. The officer who pays the commutation indorses the fact upon the furlough, and certifies upon his account of the payment that he has so done.

COMPAGNIES DE DISCIPLINE.—Companies created by Napoleon I. in 1802; the basis of their original organization was laid by a royal order in 1818. This order fixes the number of companies at ten—six of fusileers and four of pioneers, the former to be composed of soldiers of the army who were guilty of indiscipline, and the latter to be formed of men of the former who were deemed incorrigible. The number of companies is now reduced to seven, and these are stationed in Algeria. There are also four companies similarly organized which are stationed in the French Colonies.

COMPAGNIES D'ORDONNANCE.—The name of a corps of cavalry which was organized in France by Charles VII. in 1439; it numbered sixteen companies, and the entire strength was 9600 men. This was the first regular cavalry organized in France.

COMPANY.—In military organization, a company is an aliquot part of a regiment or battalion. In the British service, the companies in an infantry regiment are generally ten or twelve, or, if there are two battalions, each has this number of companies. The arrangement is made to facilitate command and evolutions. The Captains and Lieutenants are all *Company Officers*. The Captain is the chief of the company, and the Lieutenants are his subalterns or assistants. The company is further separated into two *subdivisions*, of two sections each. In round numbers, and without reference to special instances, a full company may be considered to comprise about 100 men, a subdivision 50, and a section 25. Under the Captain's superintendence the Lieutenant commands the first and second sections, the Sub-lieutenant the third and fourth, with a Sergeant to each section. Each company has its own arm and accouterment chests, and keeps its own books. A cavalry regiment is subdivided into *troops* instead of companies; the Engineers and Marines, into companies; but the artillery corresponding term is *battery*. In the German army, a company comprises about 250 men, under a Captain, who is a mounted officer, and three Subalterns.

In the United States army, all branches of the service are divided into companies. Infantry companies in time of war are expected to number about 100 men. A battalion of infantry has 10 companies, and each company has a Captain and two Lieutenants. In the cavalry a company is sometimes called a troop, and in the artillery a battery

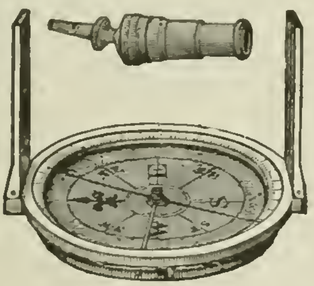
The company, dismounted, is formed in double rank, the men being arranged according to height, with the Corporals in the front rank, and on the right and left of platoons. In the right wing of the battalion, the tallest Corporal and tallest man form the right file, the shortest Corporal and shortest man the left file. In the left wing, the tallest Corporal and tallest man form the left file, the shortest Corporal and shortest man the right file. The company is divided as nearly as possible into two equal parts, called *platoons;* the division falling between two fours. For the purpose of making the platoons equal, the number of fours may be increased by leaving vacant the places of numbers two and three in some of the fours of the rear rank. When the company is small, the division into platoons may be omitted, in which case the Corporals are posted according to height on the right and left of the front rank. The company, when small, may also be formed in single rank. The right platoon, when in line, is designated the *first platoon;* the left, the *second platoon*. In column, the leading platoon is the *first*, the rear the *second*. The designations change whenever, by facing to the rear, the left becomes the right of the line, or the rear becomes the head of the column.

Posts of Officers, Sergeants, and Trumpeters or Field-music.—The *Captain* is two yards in front of the center of the company. As instructor, he goes wherever his presence is necessary. The *First Lieutenant* is two yards in rear of the center of the first platoon; the *Second Lieutenant* is two yards in rear of the center of the second platoon. Each Lieutenant is the chief of the platoon behind which he is posted. The *First Sergeant* is on the right of the front rank; the *other Sergeants* are in the line of file-closers, the *second* opposite the left file of the company, the *third* opposite the second file from the right, the *fourth* on the left of the First Lieutenant, the *fifth* on the right of the Second Lieutenant; the file-closers are as equally distributed along the line as possible. The battalion being in line, the Second Sergeant of either the left or right company places himself in the front rank, whenever his flank of the company is the flank of the battalion. The *Trumpeters*, when not united as the Trumpeters of the battalion, are in the line of file-closers, between the First Lieutenant and the Third Sergeant, and conform to all the movements of the file-closers. On the march, when the Trumpeters are required to play, they march at the head of the column. When there is a Third Lieutenant, he is posted between the First Lieutenant and the Fourth Sergeant. *File-closers* are officers or non-commissioned officers posted two yards in rear of the line; it is their duty to rectify mistakes and to insure steadiness and promptness in the ranks.

COMPANY FUND.—The savings arising from an economical use of the rations of a company (excepting the saving of flour) constitutes the *company fund*, which is kept in the hands of the Captain or other Commander of the company, and disbursed by him *exclusively for the benefit of the enlisted men of the company*, as follows: 1. For improvement of the soldiers' table-fare, and for their comfort in quarters. 2. For garden-seeds and utensils. 3. For such exercise and amusement as may be, in the judgment of the Company Commander, for the benefit or comfort of the majority of the enlisted men of the company. An account of the company fund is kept by the officer in whose hands it is deposited, which is subject to the inspection of the Commanding Officer of the post or regiment, and returns of it are rendered quarterly (or oftener if required) to the Commander of the regiment. After examination at regimental headquarters of these returns, an abstract, showing in detail the receipts and expenditures, is forwarded to the Adjutant General of the army through the Department Commander. See *Post Fund* and *Regimental Fund*.

COMPASS.—The directive power of the magnet seems to have been unknown in Europe till late in the twelfth century. It appears, however, on very good authority, that it was known in China, and throughout the East generally, at a very remote period. The Chinese annals indeed assign its discovery to the year 2634 B.C., when, they say, an instrument for indicating the south was constructed by the Emperor Hou-ang-ti. At first they would appear to have used it exclusively for guidance while traveling by land. The earliest date at which we hear of their using it at sea is somewhere about 300 A.D. According to one account, a knowledge of the compass was brought to Europe by Marco Polo, on his return from his travels in Cathay. It was long contended that the compass as a nautical instrument was first invented by Flavio Gioja, a native of Amalfi, about the year 1362; and that that part of the kingdom of Naples where he was born has a compass for its arms. For this there is no authority whatever, as the compass was well known as a nautical instrument before his time. It is probable, however, that Gioja may have made some improvement in the instrument or in the mode of suspending it.

The compass is variously mounted. The drawing shows the plain pocket-compass, having a 3-inch needle and sights folding down close to the glass. A variety of the compass known as the "dip" consists



Plain Compass.

essentially of a magnetic needle so suspended as to move readily in a vertical direction, the angle of inclination or "dip" being measured upon the divided rim of a small compass-box. When in use, the ring or bail is held in the hand—the compass box by its own weight takes a vertical position—and must also be in the plane of the magnetic meridian. In this position the needle, when unaffected by the attraction of iron, assumes a horizontal line, as shown by the zeros of the circle. When brought over any mass of iron it dips, and thus detects the presence of iron ores with certainty. If the compass is held horizontally it serves as an ordinary pocket-compass, and indicates the magnetic meridian, in the plane of which it should be held when used to ascertain the dip of the place where the observation is made. The Norwegian compass is a modification of the one used in northern Europe. It has a needle of either 3 or 4 inches resting upon a single vertical pivot so as to move freely in a horizontal direction, and thus place itself with certainty in the magnetic meridian; while at the same time, being attached to the needle-cap by two delicate pivots, one on each side, it is free to dip, like that of the ordinary compass.

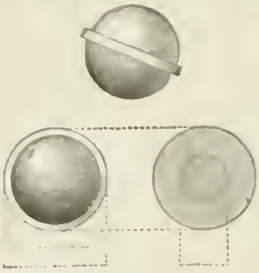
The following method of finding the points of the compass by means of a watch is novel and quite useful when traveling without the compass, or when the compass used has its needle deflected by local causes. *Halve the number of hours since the last midnight and point the corresponding dial-number toward the sun—the line from VI to XII will be then due north.* As an example, suppose the time to be 4 P.M. = 16 hours since the last midnight. Hold the watch in front of the body with the VIII pointed toward the sun: the line from VI to XII will then run due north. See *Solar Compass*.

COMPASSIONATE ALLOWANCE.—An allowance made to the children of deceased British military and naval officers left in necessitous circumstances. The annuities vary from £8 to £20 a year, according to the rank of the deceased officer, and are tenable up to the age of 18 in the case of boys, and to that of 21 as regards females, or until marriage if that happen earlier. This measure is more general than a compassionate allowance which arose out of the sympathy of the British nation with the army during the Crimean War. Royal warrants were issued in 1854 and 1856 defining and explaining allowances made to the widows and children, or other specified relations, of military officers who, after the date of the declaration of war with Russia, had been killed in action, or had died of wounds received in that war. The claims on this fund die out as years advance, of course.

COMPENSATING-GUNPOWDER.—A new mechanico-chemical explosive for heavy artillery purposes, proposed by Lieutenants A. E. Miltimore and C. A. L. Totten, United States Army. The latest American powder, hexagonal, and the English, cubical, the latter used in the 81-ton gun, are steps in retrograde. They are not accelerators: this principle has been sacrificed to the attainment of density and uniformity. These forms of powder beautifully illustrate the relation between a large surface of combustion and a diminished strain upon the gun, and thus fulfill their mission; still they are but temporary expedients. It is different, however, in the case of the perforated cake. Powder thus treated conserves its force well and strains the gun toward the minimum, and for this reason it has very naturally been adopted by one of the greatest military powers in Europe, for use in the strongest gun. In the mean time, with the detonating class of explosives we have been mainly engaged in reducing the intensity of their action, nor have any of them yet come within the limits of artillery requirements. Explosion in the case of gun-cotton is not combustion; it is more of a disintegration, a loss of equilibrium, taking place as it were instantly throughout the entire mass.

Both of these explosives possess valuable resources for the artillerist, yet neither of them fulfills in itself all the requirements of a projectile agent. While powder has considerable, gun-cotton has almost unlimited power; the explosion of the former can be governed, that of the latter has hitherto been unruly. But the very means we take to curb the first force of powder reduces to a minimum its already relatively small power-capacity. If we could obtain an explosive whose action would be similar to that of hexagonal powder until the projectile had taken up a rapid velocity, and which should then burn up with all the energy of gun-cotton, we would have a most valuable accelerator.

The endeavor to use these two substances in combination led to the invention of compensating-powder. The idea is to "build up" grains, cakes, or masses out of two or more explosives, or out of the same explosive in varying conditions, in such a manner that these explosives shall be ignited *successively* by the actual combustion of the several layers down to them. For instance, suppose we have a large grain of such powder. Its form, for discussion, is immaterial; let it be a sphere of gunpowder an inch in diameter, and imagine it to possess an interior and concentric core of gun-cotton half an inch in diameter. Such a grain would be constructed with a scientific regard to the peculiar characteristics of each substance, and would evidently burn upon the accelerative principle. Let us examine the theoretical combustion and effect of a charge of such powder fired in a gun. The relative amounts of the two explosives would satisfy the demands of the compensating principle, and at the same time the reasonable precaution of reducing the more explosive substance to its minimum effective quantity. Immediately after inflammation the gunpowder would commence to be rapidly consumed in towards the cotton. The exterior layer burning first would prepare the way for the more violent explosion of the interior one, and being itself in large grains, would offer a minimum surface to combustion during its first and most decisive instants. The powder part of the grain would thus be suited to large charges and guns.



It takes but a few one-hundredths of a second for all the powder to be consumed. In the mean time the projectile will have acquired its motion as in the case of the ordinary charge of powder alone, for thus far there has been no difference in the explosion, and will have reached a point in the bore beyond which, with powder alone, no material gain is to be realized from the gun's length. The small amount of powder which would now remain unconsumed, were the grain homogeneous, would barely evolve gas rapidly enough and in sufficient quantities to fill up, or *compensate* for, the increasing space behind the projectile, and would, of course, be useless for acceleration. For all practical purposes a powder-grain might as well be *hollow* from this point inwards. But just here the valuable part to be played by the interior core of the compensating grain is to be noticed. Exploding at this moment with great rapidity and force, it checks any tendency of the gas to lose its tension, compensates for the increasing space in rear of the projectile, and indeed actually gives it a final and valuable accelerating impetus. The great force thus developed by the gun-cotton in this last stage will not be exerted against the walls of the gun, as would be the case in the explosion of a charge of gun-cotton alone, but will evidently be directed towards the line of least resistance thus artificially prepared for it. The cotton, in fact, will find a condition of affairs in the bore of the gun that is especially favorable for its action. It is no longer confined to a space just sufficient to contain it before combustion, but finds a continually increasing one into which to expand, a cushion of gas against which to impinge, and an already rapidly moving projectile to accelerate.

In the employment of mammoth powder, even in its most approved form, we have to contend against a very serious element—*wastage*. These large grains are found to be only partially consumed; still burning they are thrown out of the gun along with the projectile. That is, when the combustion has reached a certain point the projectile leaves the gun, and all the powder remaining unconsumed is wasted. This waste reaches the enormous amount of 60 per cent. The introduction of an interior core of higher explosive properties can be made to do away with this expensive loss. Forty pounds of powder do all the work in a service-charge of one hundred pounds. Reckoning gun-cotton as only four times the strength of gunpowder, fifteen pounds of it would be equivalent to the sixty pounds of powder that are wasted. If, then, we imagine this amount of cotton introduced as a core into the forty *working* pounds of powder (the size and number of the grains remaining the same), we shall have a charge stronger, by the equivalent of sixty efficient pounds, than the present service-charge of the 15-inch Rodman gun. It must be remembered, moreover, that such a charge will expend its first forty pounds in impressing the projectile with its present normal velocity (1500 or 1600 feet), and that the remaining 15 pounds (*once and a half the value of the first forty*) of force-generator will work under the most favorable circumstances as a pure accelerator. We shall thus eliminate the great waste of the one, curb the straining action of both, and obtain a true *artillery powder*,—lighter and four and one half times more effective, charge for charge, than our best gunpowder.

It will, perhaps, repay us to examine this proposed combination, and its constituent parts, under their chemical symbols. The theoretical burning of gunpowder is expressed by the following equation:

$$2NO_3K + 3C + S = 3CO_2 + 2N + SK_2 \ldots\ldots\ldots (A)$$

The explosion of the gun-cotton is given by the formula

$$2C_6H_7(NO_2)_3O_5 = 3CO_2 + 9CO + 6N + 7OH_2 \ldots (B)$$

In the explosion of compensating-powder, the element *succession* is most noticeable. This is favorable to the stability of the several gases of its constituents when *brought together* under such peculiar conditions. The similar nature of the products of combustion of gunpowder and gun-cotton seems to preclude any tendency (which very *dissimilar* gases might have) to result differently in combination than they do when separated. Hence we may simply combine these two reactions by addition, and obtain a legitimate expression for the explosion of compensating-powder, namely:

$$[2NO_3K + 3C + S] + [2C_6H_7(NO_2)_3O_5] = (3CO_2 + 3CO_2) + 9CO + (2N + 6N) + 7OH_2 + SK_2 = 6CO_2 + 9CO + 8N + 7OH_2 + SK_2 \ldots\ldots\ldots (C)$$

It is barely possible that the water in this reaction may be turned to account for the oxidation of the sulphide. But in this case *hydrogen*, a still more elastic gas, would be freed, and take the place of the steam. Such a variation would result in greater chemical action and therefore in the production of a higher temperature, all of which would finally be appreciated in ballistics as an accelerator. Comparing these reactions critically, we may obtain a very clear idea of the gas-capacity and character of the powder that will result from the combination proposed. It must be recalled, in this comparison, that while the powder-gases result from a progressive *combination* of its elements, those of the detonator come from its almost instantaneous *disintegration*. It is also to be noticed that the volume of the latter gases is many times greater than that of the former, and, from the large amount of water it contains, that it has all the elasticity of steam.

It is claimed that gunpowder itself acts as an accelerator, from the fact that the great heat of its confined explosion must expedite the change into gas of its interior layers,—just as a coal-fire burns better and better until it reaches its maximum. This is obviously the case, though it is not an appreciable argument when offered against a combination that *is* a noticeable accelerator. This very feature, however, will work in favor of the compensating construction, for the accelerated burning of the powder-jacket will only be of importance during a very brief period, until the grain has become relatively small,—beyond this point it is valueless; but the interior core explod ing at this same moment will take up and carry to its climax this action, so well begun. See *Gunpowder*.

COMPLEMENT OF THE CURTAIN.—That part in the interior side of a fortification which makes the demi-gorge.

COMPLEMENT OF THE LINE OF DEFENSE.—The remainder of the line of defense after the angle of the flank is taken away.

COMPLIMENT.—The usual military marks of respect shown by a body of troops to official personages, to an officer, or to another body of troops.

COMPONE.—A term in Heraldry synonymous with Gobony. When a bordeur, pale, bend, or other ordinary, is made up of two rows of small squares, consisting of alternate metals and colors, it is called *componé*. See *Heraldry*.

COMPOSITIONS.—The term *composition* is applied to all mechanical mixtures which by combustion produce the effects sought to be attained in pyrotechny. If these compositions be examined, it will be found that many of them are derived from gunpowder, by an admixture of sulphur and niter, in proportions to suit the required end. Compositions are prepared in a dry or liquid form; in either case it is necessary that the ingredients should be pure and thoroughly mixed.

For dry compositions the ingredients are pulverized separately, on a mealing-table, with a wooden muller; they are then weighed and mixed with the hands, and afterwards passed three times through a wire sieve of a certain fineness. When a highly oxidizing substance, as the chlorate of potassa, is present, great care must be observed in mixing to avoid friction or blows which might lead to an explosion. When coarse charcoal or metals in grains are used, they should be added after the other ingredients have been mixed and sifted.

When it becomes necessary to use fire to melt the ingredients, the greatest precaution is necessary to prevent accident, especially when gunpowder enters. The dry parts of the composition may be generally mixed together first, and put by degrees into the kettle, when the other ingredients are fluid, stirring well all the time. When the dry ingredients are very inflammable, the kettle must not only be taken from the fire, but the bottom must be dipped in water to prevent the possibility of accidents.

The following table shows the rate of burning of the more important compositions:

Dimensions.	Wheel-fires.			Standing-fires.		
	Common	White.	Chinese.	Sun.	Star.	Roman candles.
Length of case .... inches	8.75	8.75	8.75	11	8	19
Interior diameter .... do.	0.75	0.75	0.75	0.75	0.75	0.75
Weight of composition .... ounces	3.5	3.5	4	5	4	5
Time of burning, per inch .... seconds	17	17	21	22	20	45

Dimensions.	Lances.					Port-fires.						Changeable wheels.
	Red	White.	Blue.	Yellow.	Green.	Red.	White.	Blue.	Yellow.	Green.	Lilac.	
Length of case .... inches	4	4	5	4	4	3	3	3	3	3	3	3
Interior diameter .... do.	0.32	0.32	0.32	0.32	0.32	1	1	1	1	1	1	0.75
Weight of composition ...... grains	141	140	150	150	160	547	560	546	545	560	550	250
Time of burning .... seconds	90	90	90	90	90	60	65	45	65	65	45	60

See *Cases* and *Fire-works*.

COMPOSTELLA.—St. James, the elder, was adopted as the patron saint of Spain, after the victory of Clavijo, and his relics were preserved at Compostella, the capital of the province of Galicia. The marvels supposed to be performed by these relics drew vast numbers of pilgrims, for whose support hospitals were established by the pious canons of St. Eloy. The vicinity of the Moors having subsequently rendered the highroads unsafe, 13 noblemen united for the protection of the pilgrims, and, in conjunction with the canons, resolved to found an Order of the same kind as that of the Hospitallers or Templars. The Pope granted his assent in a bull, dated 5th July, 1175, accompanied with the statutes of the Order. Whatever conquests were made from the infidel were declared the property of the Order, and a council of 13 knights was vested with authority to elect and depose a Grand Master. The knights made vows of poverty, obedience, and celibacy, and professed their belief in the Immaculate Conception. To protect Christians and convert infidels they vowed to be the only object in their wars with the Saracens. In most of the great battles between Christian and Moor the red cross of the Order was conspicuous. The conquests of the Order itself, combined with the grateful munificence of the nation, speedily increased its wealth and power beyond those of any of the other orders of knighthood. In addition to the three large commanderies of Leon, Castile, and Montalvan, it possessed nearly 200 minor commanderies, comprising, it is said, more than 200 priories, with many fiefs, cloisters, hospitals, castles, boroughs, two towns, and 178 villages, exclusive of its possessions in Portugal. This enormous wealth and power of the Order excited the jealousy of the Crown, in which, in 1522, the Grand-mastership was permanently vested by the Pope. Having thus become merely honorary and dependent on the Crown, the order rapidly decreased in importance.

Cross of the Order Compostella.

COMPRESSED BRONZE.—The density and hardness of bronze have been increased by tempering, by compression when in a fluid state, and, with still greater success, by the process of Mr. Dean, first tried in the United States in 1868, and a method exactly similar introduced by General Uchatius in Austria in 1873. The latter experimented with bronze cannon compressed whilst fluid, with others cast about a copper core, and finally with the plan proposed by Mr. Dean, which consisted in casting the piece solid in an iron mold or "chill," and, after boring it to near the required size, compressing and hardening the layers of metal by forcing into the bore a series of mandrels or plugs of hard steel. Guns so made compare most favorably with those of banded steel; they have internally the same strength, homogeneity, and hardness, and the elasticity increases from the exterior toward the interior. They show no spots of tin, and the alloy, not being brittle, is much less subject to erosion than ordinary bronze. General Uchatius considered erosion to be the result of a purely mechanical action, and that brittle metal, or in bronze guns the hardest parts, was most liable to be so affected. Mr. Dean increased the density of his bronze from 8.321 to 8.875, and the tenacity from 27,238 lbs. to 41,471 lbs. per square inch, whilst General Uchathus obtained a tenacity of over 72,000 lbs. This mode of construction has been adopted by the Austrian Government, and is now being tried in the United States. See *Bronze*.

COMPRESSION-PROJECTILES.—The systems under this class differ in the nature and arrangement of the metal to be compressed. Solid shot, shells, and shrapnel can be used in each. A projectile of this system is composed of a cast-iron or steel body, and of a lead coating cast over and between rings projecting from the body of the projectile. Bands of lead, extending beyond the general surface, are compressed by the lands as the projectile is forced through the bore of the piece. A construction more generally used is to have the body smooth, and to attach the coating chemically; to accomplish this, the body is thoroughly cleaned, and immersed in a solution of sal-ammoniac; next it is covered with powdered sal-ammoniac, and dipped first into melted zinc and afterwards into melted tin; it is then placed in a metal mold and the lead cast upon it. The hole in the base is closed by a screw-plug, which has a ring for handling the projectile and for extracting it from the piece when necessary.

In the French system these projectiles have two *bands*, B and B , of copper, attached by being forced into annular undercuts as shown in the drawing. To favor the compression, triangular grooves are cut around the surface of the bands. The forward band is placed near the center of gravity of the projectile; its diameter is only about .02 inch greater than the caliber of the piece, and therefore does not assist in giving rotation, but only in centering the projectile; the accuracy of fire is thereby increased, but the velocity at the muzzle of the piece is slightly reduced. See *Coated Projectiles*, *French Projectiles*, and *Projectiles*.

COMPRESSIVE SYSTEM OF RIFLING.—This system embraces all projectiles which are loaded in a chamber and then forced by the action of the powder through the bore of the gun, the diameter of which across the lands is less than the superior diameter of the projectile. Projectiles of this class are necessarily confined to breech-loading guns, and, as the name of their class implies, take the grooves by compression. The general character of the rifling in breech-loaders consists in a great number of shallow grooves usually narrowing toward the muzzle to make up for the slip and abrasion of the leaden jacket of the projectile. The Armstrong system of rifling for breech-loaders, formerly used in the English service, does not differ in principle from this. The rifling consists of a great number of shallow, narrow grooves (the 7-inch has 76), the object being to give the soft-metal covering a very large bearing on the driving-side of the grooves, and thus prevent stripping, and make up for want of depth. See *System of Rifling*.

COMPULSION.—A constraint upon an officer's will whereby he is compelled to do that which his judgment disapproves, and which, it is to be presumed, his will (if left to itself) would reject. As punishments are, therefore, only inflicted for the abuse of that free will which God has given to man, it is highly just and equitable that an officer should be excused for those acts which are done through unavoidable force and compulsion.

COMPULSORY SERVICE.—The power a government has of compelling the people of a country to take up arms in defense of the nation. This nature of enlistment is unknown in the British army, except in the militia, and then only in case of a deficiency of recruits; but in Continental armies the system is universal.

COMRADE.—A fellow-soldier in the same regiment or company, and who acts as the friend of another soldier. The term *comrade* is also extended so as to include all the members of a particular corps, branch of the service, or the army generally.

CONCAVE ORDER OF BATTLE.—If an attack is made simultaneously on both wings, and the center is refused, the attacking army will assume a line of battle which will be concave towards the enemy's line. If the attacking army possesses a decided superiority in numbers, this order obtained by a simultaneous attack on both wings and refusing the center might be employed. It is evident that even in this case mutual assistance could not be given by the troops making the attacks, and it would possess all the defects of a division of forces upon the field of battle. This order of battle was used by Hannibal when he won his great victory over the Romans at Cannæ. Circumstances will generally decide when this order of battle should be used; all other things being equal, it should not be used in preference to the oblique order. See *Convex Order of Battle*.

CONCENTRATION.—Collection into a narrow space round a center. In strategy, the collecting on a certain point of the different bodies forming an army, to meet the enemy with the greatest number of men possible. For a General to divide his forces, unless for special purposes, is to court defeat in detail. An instance of this is afforded by the War of 1870–71, when the French, divided into six separate *Corps d'Armée*, incapable of supporting each other, were defeated piecemeal by the Germans, who had concentrated all their forces into three powerful armies.

CONCENTRATION-MARCHES.—Marches made by several bodies of troops starting from points separated from each other for the purpose of bringing these troops together at some stated place. Forced marches are much used in concentrating troops, especially before a battle. Many examples are given in military history. As strategical operations, marches may be divided into two principal classes: those of *concentration* beyond the sphere of action of the enemy, and those of *maneuver* executed within this sphere. In the former the forces are only brought to that point where the latter commences. In the campaign of 1805 it is noted that the two corps in Hanover and Holland, under Bernadotte and Marmont, were directed upon Wurtzburg, whilst those on the English Channel were directed on the Rhine between Mannheim and Strasburg. Having reached these points without any apprehension of an enemy's presence, the grand maneuver for throwing them on the enemy's right flank and rear commenced; those columns on the right, being nearer the enemy, moving more slowly, and having their flank nearest the enemy carefully guarded by a corps assigned to this service; those on the left moving more rapidly and pivoting on the right; whilst the whole was so combined that in a few hours a large force could be concentrated on any fraction, if unexpectedly attacked whilst carrying out this grand movement.

In the second splendid campaign of Napoleon in Germany against the Austrians, that of 1809, the same admirable series of provisions is to be seen. Seeing the evidently hostile attitude of Austria, the first step of Napoleon was to mass his forces at those points from which they could be rapidly thrown upon the Austrian dominions. For this purpose he chose Wurtzburg, Augsburg, and Strasburg as the points for concentration. On and towards the first point he directed the major part of his forces from Saxony and from the north of Germany; on the second, the forces in the neighborhood of Hanau; on the third, those from the interior of France. Whilst in Italy he directed Prince Eugene with 50,000 men to approach the Frioul. These, with other minor movements, drew around Austria another of those Napoleonic meshworks which had already proved so disastrous to her. The Austrian army of 200,000 men were to concentrate in the neighborhood of Ratisbonne, on the Danube; part on one side and a part on the other side of this stream, but so as to render mutual assistance. Not knowing where he with certainty should find the main body of the Austrians, Napoleon decided upon trusting nothing to mere hazard, but to be governed in his movements by recognized military principles. To this end he withdrew Davoust from Ratisbonne, on the Danube, and threw forward Massena so as to concentrate his entire force at Ahensburg, a small place on the river Abens, and about midway between Ingoldstadt and Ratisbonne. Here he decided to break through the Austrian center, thus separating the two Archdukes, Charles and Louis. In these plans he was aided by the tardiness of movement of the Austrians upon which he counted, and also by the state of the weather, by which the roads were much injured. The result of these skillfully combined marches was that the Archduke Charles was forced upon Ratisbonne, and obliged to retreat across the Danube into Bohemia; the other main fraction of the Austrian army retiring successively behind the Inn and the Traunn, leaving the road to Vienna open to Napoleon.

In this conjuncture of operations, Napoleon, after considering the military aspect of affairs, decided to march direct upon Vienna. In taking this step he had not only to follow up the Archduke Louis, but to provide against the junction of the Archduke Charles with him, by recrossing the Danube. The principal points where this passage might have been effected are Straubing, Passau, Lintz, and Krems. These it was of the first importance to secure by anticipating the Austrian movements on them. To carry out these measures, Massena received orders to descend along the Danube, to be followed by Davoust, and by General Dupas; and each in succession to occupy the places just mentioned, thus securing the army from an attack either in flank or in rear by the Austrians on the left bank of the Danube. At the same time Bessières was ordered to push forward beyond Landshut, on the Iser, and keep closely on the heels of the enemy's retreating column; whilst Lannes, under the immediate command of Napoleon, moved between the columns of Massena and Bessières, so as to throw this force upon either of these two, as circumstances might demand. Further to secure his right on their flank, the Bavarians, his allies, were directed to occupy Munich, and, pushing from there through Salzburg into the Tyrol, observe the Archduke John, and give timely warning of his movements. These profound combinations met with all the success they merited. Anticipated by the rapid movements and daring of the French at every point, the Archduke Charles was unable to join the forces on the right bank of the Danube, which last, despairing of being able to cover Vienna, effected a crossing to the left bank at Krems. See *Marches*.

CONCENTRIC.—Having a common center. This term in warfare is applied to a covering army operating from a common center against widely separated bodies of the enemy advancing towards that center; hence it becomes a concentric army. The invasion by the enemy may take place either on one or two lines. To operate methodically, and to the best advantage, the covering army, if assailed on two lines, should place on each of these a retarding force at first, considering these as wings, while the mass in reserve is held ready to give a preponderance to either wing, or to both in succession. In all Napoleon's operations against a divided enemy this principle is apparent. See *Concentration-marches*.

CONCRETE.—A mixture of hydraulic or other mortar with gravel or shingle, which, on hardening, forms an artificial conglomerate. The best concrete is made by well mixing hydraulic mortar (see CEMENT) with sand and sufficient water for complete hydration, and then adding the shingle or screened ballast, and mixing them well together. An inferior concrete may be made by laying the shingle into the foundation or other place where the concrete is required, and then pouring mortar upon it, to fill the interstices between the pebbles. The principal use of concrete is to form a basis of artificial stone for buildings that rest upon loose or damp subsoils. Such a basis, if well made, forms a solid foundation-slab upon which the weight of the whole structure is equally distributed. It also resists the capillary ascent of moisture from the soil, which would otherwise take place through brick-work or porous stone.

CONCUSSION-FUSE.—A fuse put in action by the discharge, but the effect of that action is restrained until it strikes the object. Such a fuse, in order to be serviceable, must not only produce explosion on striking, but it must not produce it on the shock of the explosion of the charge, nor of that produced by the ricochets of the projectile in or out of the gun. These fuses have usually consisted of some combination of the highly explosive fulminates, but the extreme danger of using them has been a great obstacle to their adoption. See *Fuse*, *Percussion-fuse*, and *Splingard Fuse*.

CONDEMNED ANIMALS.—Animals in the public service condemned as unfit for work. In the United States army, all horses and mules inspected and condemned as unfit for military service are advertised for sale, and disposed of within ten days from date of advertisement, and if not sold within the ten days are shot on the eleventh day. The advertisement is made in accordance with advertising regulations in force, but at posts remote from places where newspapers are published the advertisement is made by posted notice. When horses and mules condemned are sold, or, in default of sale, shot, report is made at once to the Quartermaster General, through the regular military channel, of the execution of the order. Great care is exercised in the branding of condemned horses and mules with the letters I. C. (Inspected—Condemned).

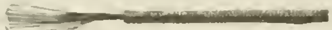
CONDEMNED PROPERTY.—In the military service, property unfit for further service and worthless. Property unfit for the purpose for which it was designed may often be applied to other uses. Inspecting officers, in recommending the disposition to be made of condemned property, especially of the Quartermaster's Department, should bear in mind that there is hardly any species of material, however worn, which cannot be put to some use. Old linen, cotton, wool, iron, etc., can all be worked up in some new form, and wood can be used as fuel. No condemned articles that have any salable value should be recommended "to be dropped," unless there be special reasons therefor, which reasons should be stated in the report. The Inspector should mark the letters I. C. (Inspected—Condemned) upon all property condemned and ordered to be dropped from the returns, with a brand, stencil, cold-chisel, steel cutter, or punch, depending on the material to be marked. Should it happen, when final action is had, that the Inspector's recommendation is disapproved, the marks should be canceled, and a certificate of the fact given to the officer accountable. See *Inspection of Condemned Property*.

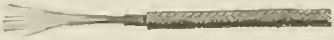
CONDOTTIERI.—The name given in the fourteenth century to the leaders of certain bands of military adventurers who, for booty, offered their services to any party in any contest, and often practiced warfare on their own account purely for the sake of plunder. These mercenaries were called into action by the endless feuds of the Italian States during the Middle Ages. Among the most celebrated of their leaders were Guarnieri, Lando, Francis of Carmagnola (about 1412), and Francis Sforza (about 1450). The last-mentioned made himself Duke of Milan. The *Compagnies Grandes* in France, during the fourteenth century, resembled the bands led by the Italian Condottieri. They originated in the long bloody wars between France and England. The mischief done by them became so intolerable that in several parts of the country the peasantry armed themselves and, under the name of *Pacifères*, formed associations against the plunderers. Nevertheless, these French Condottieri were so powerful that, in 1361, they routed the king's forces which had been sent against them, at Brignais, near Lyon, and slew the Constable of France, Jacques de Bourbon; but the Constable du Guesclin persuaded them to seek their fortune in the Spanish service.

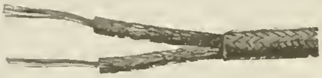
CONDUCTORS.—1. In the Royal Artillery, Conductors are those artillerymen who have charge of the ammunition-wagons in the field; they are, to some extent, under the control of the Commissariat Officers, who have to provide means of transport; but since the recent changes in the Commissariat Department they have been more exclusively under the control of their own proper artillery officers.

2. Conductor, in electricity, is a term applied to a body capable of transmitting an electric current. If a rod of metal be made to touch the prime conductor of an electrical machine immediately after the plate has ceased to rotate, every trace of electricity immediately disappears. But if the rod were of shellac, little or no diminution would be perceptible in the electrical excitement of the conductor. The metal in this case leads away the electricity into the body of the experimenter, and thence into the ground, where it becomes lost, and it receives in consequence the name of a conductor. The shellac, for the opposite reason, is called a non-conductor. Different substances are found to possess the power of conducting electricity in very different degrees. The following series classifies the more common substances according to their conducting powers, beginning with the best and ending with the worst conductors: Conductors—The metals, graphite, sea-water, spring-water, rain-water. Semi-conductors—Alcohol and ether, dry wood, marble, paper, straw, ice at 32° F. Non-conductors—Dry metallic oxides, fatty oils, ice at 13° F., phosphorus, lime, chalk, caoutchouc, camphor, porcelain, leather, dry paper, feathers, hair, wool, silk, gems, glass, agate, wax, sulphur, resin, amber, and shellac.

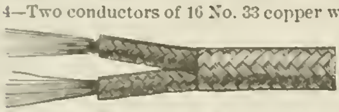
The arrangement into conductors, semi-conductors, and non-conductors is made with reference to frictional electricity, or electricity of a high tension. The substances which are semi-conductors for frictional electricity are found to be almost, if not altogether, non-conducting for the electricity of the galvanic battery, which is too feeble to force a passage through them. The metals, which appear to be all nearly alike conducting for frictional electricity, offer widely differing resistances to the transmission of the galvanic current. By experiments made with galvanic electricity, it is found that the more ordinary


No. 1—One conductor of 16 No. 33 copper wires.

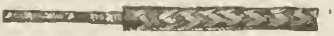

No. 2—One conductor of 16 No. 31 copper wires.

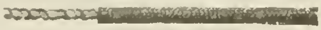

No. 3—Two conductors of 5 No. 30 copper wires.

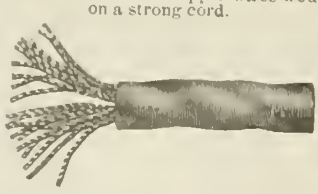

No. 4—Two conductors of 16 No. 33 copper wires.

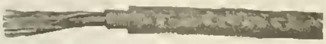

No. 5—Two conductors of 30 No. 33 copper wires.


No. 6.—One conductor of 8 No. 36 copper wires.


No. 7—One conductor of copper wires wound spirally on a strong cord.

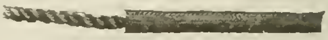

No. 8—One conductor of small copper wires wound spirally on a strong cord.


No. 9—Two conductors, heavy switch-cord, Western Union style, each conductor composed of 10 flat copper wires wound spirally on cord, each conductor heavily wrapped with silk.

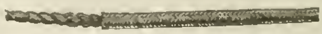

No. 10—One conductor of 50 No. 32 copper wires, with green and gold colored silk braid cover. For Rheostats and other purposes where large and flexible conductors are required.


No. 11—One conductor, tinsel cord, with lateral cotton and double wrap of cotton cover. Much used for Kidder and other battery electrodes.


No. 12—Two conductors of 14 No. 33 copper wires in strands insulated with silk, and laid up in form of three-strand cord.

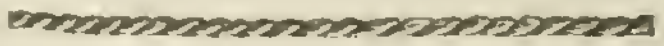

No. 13—One conductor, tinsel cord, covered with worsted braid.

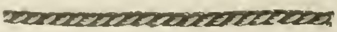

No. 14—Two conductors, tinsel cord. Both conductors covered with worsted braid, the whole covered with fine worsted braid.


No. 15—One conductor, tinsel cord, covered with silk braid


No. 16—One conductor, tinsel cord. One wrap of worsted and two cotton braids outside. For telephone-switches.


No. 17—Two conductors of 25 No. 36 copper wires, each conductor insulated with a wrap of cotton, a layer of gutta-percha, and an outside braid of silk. This is an entirely water-proof cord, much used in electric lighting.


No. 18—Gold tinsel cord, not covered, small size.


No. 19—Gold tinsel cord, not covered, large size.

metals stand thus as regards their powers of conduction, beginning as before with the best conductor: Silver, gold, copper, brass, zinc, iron, platinum, tin, nickel, lead, German silver, mercury. An increase of temperature has in the metals the effect of lessening the conducting power, whilst in almost all other substances it has an opposite effect. Glass becomes conducting at a red heat, and so do wax, sulphur, amber, and shellac, when fused.

When a conductor is placed on non-conducting supports, so as to prevent the electricity communicated to it from passing into the ground, it is said to be insulated. The usual insulating material employed in the construction of electrical apparatus is glass, which, though not so perfect a non-conductor as the others lower in the scale, far exceeds them in hardness and durability. In a damp atmosphere glass becomes coated with a thin layer of moisture, which very considerably diminishes its insulating power. Hence arises the necessity in certain states of weather of heating so as to dry all electrical apparatus previous to use. This imperfection is very much lessened by covering the glass with shellac varnish. The very fact that a conductor may be insulated indicates that the air is a non-conductor. Dry air possesses this property in a high degree, while moist air renders insulation for any length of time impossible.

The drawing shows a variety of conducting cords, manufactured by Messrs. L. G. Tillotson & Company, New York, and used for various military purposes, principally in ballistic experiments and sub-marine mining. See *Mines*.

CONDUCT PREJUDICIAL TO MILITARY DISCIPLINE.—All crimes not capital, and all disorders and neglects, which officers and soldiers may be guilty of, to the prejudice of good order and military discipline, though not mentioned in the Articles of War, are taken cognizance of by a General, or a Regimental, Garrison, or Field-officers' Court-Martial, according to the nature and degree of the offense, and punished at the discretion of such Court. See *Articles of War*.

CONDUCT UNBECOMING AN OFFICER AND A GENTLEMAN.—This offense is punished with dismission by sentence of a General Court-Martial. What constitutes the offense is not defined, but it is left to the moral sense of the Court-Martial to determine.

CONE.—The vent-plug which is screwed into the barrel of a fire-arm. The outer end is the *nipple* for receiving the percussion-cap. The functions of the cone are to support the percussion-cap when exploded by the hammer, and to conduct the flame to the vent of the piece. To increase the effect of the hammer, the upper surface of the *cone* is diminished by chamfering the corners. See *Barrel*.

CONE OF DISPERSION.—The cones of dispersion of projectiles comprise all the causes of error in firing, whether resulting from the arm itself, from the projectile and the resistance of the air, or from the want of practice or skill in the marksman. The causes of irregularity in firing, although greater in the horizontal than in the vertical direction, are considerable in the latter. They raise or depress the projectiles, and change the ranges to an appreciable extent. The general form of the *cone of dispersion* will present a curved surface, which is concave outwards; for experiment goes to prove that when a variable cause acts an infinite number of times, the variations of this cause tend to neutralize each other, and we may then assimilate its effects to those of a constant accelerating force, acting in the same manner as gravity. The separation of the projectiles is not in proportion to the ranges, but increases more rapidly. The *cone of dispersion* becomes longer, with equal deviations, as the velocity of the projectiles increases; or in other words, the fire is more accurate as the velocity is increased. Ancient artillerists were aware of this principle, and in consequence employed for small-arms charges much larger than those now in general use.

CONE OF SPREAD.—The imaginary cone containing the diverging bullets or fragments upon the explosion of a shell. With shrapnel shells this *cone* is very long; while with segment shells it is very short and wide, and these shells are consequently most effective when burst close up to the object. See *Cone of Dispersion*.

CONE-SEAT.—A projecting piece of iron welded to the barrel, near the breech, for the purpose of sustaining the cone. See *Barrel*.

CONFEDERATE PROJECTILES.—The rifle-projectiles used by the Confederates in the late war belonged, with a few exceptions, to the expanding class. Fig. 1 represents a shell with a copper ring (*b*) fitting into a rabbet formed around its base in casting. This projectile would seem to resemble the Parrott projectile in its construction. The lower edge of the band, however, projects below the bottom of the base, which in Parrott's it does not. Recesses are formed in the sides of the rabbet to prevent the ring from turning.

The projectile represented in Fig. 2 has a thick circular plate of copper attached to its base by means of a screw-bolt at its center. To prevent it from turning around this bolt there are three pins, or dowels, fastened into the base of the projectile, and projecting into corresponding holes in the circular plate. This plate is slightly cupped, and the angle between it and the bottom of the projectile is filled with a greased cord for lubricating the bore of the gun.

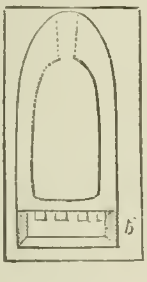


Fig. 1.

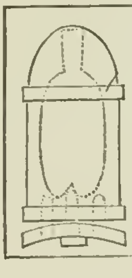


Fig. 2.

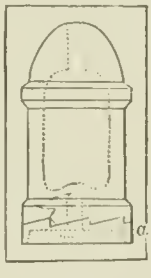


Fig. 3.

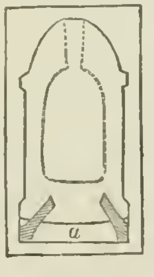


Fig. 4.

Fig. 3 represents a projectile of the Blakely class, with its expanding cup of copper (*a*). Instead of the soft-metal studs which are placed on the forward part of the Blakely projectile, this projectile has a raised band carefully turned to fit the bore.

Fig. 4 represents a Reed projectile, in which the expanding cup is made of copper, as shown at *a*. This cup is placed in the mold, and the body of the projectile is cast upon it. See *Expanding Projectiles* and *Projectiles*.

CONFEDERATION.—An alliance of Nations, States, or Princes; sometimes used for a single Nation, as that of the Mexican Republic, the official title of which is "The Mexican Confederation." The German Confederation was formed immediately after the Vienna Congress of 1815. In July, 1778, the United Colonies (afterwards the United States of America) agreed to the "Articles of Confederation and Perpetual Union between the States of New Hampshire, Massachusetts Bay, Rhode Island and Providence Plantations, Connecticut, New York, New Jersey, Pennsylvania, Delaware, Maryland, Virginia, North Carolina, South Carolina, and Georgia." In these Articles are set forth the principles of government which were a few years later embodied in the Constitution of the United States, with such additions as were necessary "in order to form a more perfect union." In South America is the Argentine Confederation, and Switzerland is sometimes called the Swiss Confederation. The Confederation of the Rhine was formed in 1806 by a number of German States, under the protection of Napoleon.

CONFIDENCE.—This term, in a military sense, has reference to the facility with which some officers gain the confidence of their men. This most essential quality in a Commander is of the highest importance, and cannot be overrated: without it, a disaster may at any moment occur in the day of battle; but with it, and the knowledge of military science combined, success in the operations of an army may be assured. History affords examples of battles having been lost by the most celebrated Generals because they did not possess this confidence. At the battle of Thymbra, when Cyrus's horse fell under him, Xenophon takes notice of what importance it is to a Commander to be loved by his soldiers. The danger of the king's person became the danger of the army; and his troops on that occasion gave incredible proofs of their courage and bravery.

CONFIDENTIAL REPORTS.—Reports on Regiments, as to their efficiency, conduct, etc., forwarded yearly, in England, by General Officers Commanding to the Adjutant General for the information of the Commander-in Chief. Reports on the qualifications of officers for promotion are sent to the Military Secretary at the Horse-guards for submission.

CONFINEMENT.—Non-commissioned officers and soldiers charged with crimes are usually confined until tried by Court-Martial or released by proper authority. No officer or soldier who is put in arrest should continue in confinement more than eight days, or until such time as a Court-Martial can be assembled.

CONFISCATION.—The appropriation to the public use of private property. A right which is conferred under certain circumstances by the laws of war. See *Contraband of War*.

CONGREVE GUN.—A 24-pounder gun of conical form, proposed in 1813 by Sir W. Congreve. It had a much greater thickness of metal at the breech than those of the old construction; the extra thickness was supposed to give a reacting power to the gun, which, however, is an erroneous idea, not supported by facts. The gun is now obsolete,

CONGREVE ROCKET.—A rocket guided by a long wooden stick attached to its base, and a terrible weapon of war, with ranges which no ordnance of its time could attain. Discarding the small sizes, Congreve made 12-pound, 18-pound, and 32-pound rockets, which he charged with canister-shot, bullets, and other missiles. The stick for a 32-pound rocket was 18 feet in length, and the maximum range 3500 yards. The range could be increased by discharging the rocket from a cannon, with a time-fuse to ignite it at the cannon's utmost range, when the rocket commences its own course. As missiles, these rockets were found to annoy most seriously the defenders in any fortified work, and, in a bombardment, they speedily set houses and buildings on fire. In the field, also, the plunging, ricochetting motion of the rocket greatly disturbed both cavalry and infantry. The Congreve rockets were first tried on actual service, and with fatal effect, at the attack on Copenhagen in 1807. See *Rocket*.

CONROY RIFLE.—A breech-loading small-arm having a fixed chamber closed by a movable breech-block, which rotates about a horizontal axis at 90 to the axis of the barrel, and lying above the axis of the barrel and in rear—being moved from below. This arm is provided with a falling breech-block, moved by a sliding trigger-guard, the withdrawal of which retracts the firing-pin, brings the hammer to the half-cock, and drops the block, which strikes in its descent and operates the usual bent-lever extractor. By pushing the trigger-guard forward again, the block is raised, when by bringing the hammer to the full-cock the piece is closed and ready to be fired. The blow of the hammer is not delivered directly upon the firing-pin, but on an intermediate lever pivoted below its point of impact on the firing pin, and striking it so as to impel it forward in the line of the axis of the bore. This gun has been modified by substituting for the sliding guard the more powerful motor found in the usual swinging guard-lever, the angle formed by which with the stock when the piece is opened being about 30°.

CONSCRIPTION.—The system whereby the French, since the year 1795, and some other foreign armies are recruited. It differs essentially from the English system in being compulsory, and, taken for all in all, as a disturbance of the system of employment in all grades of society, is probably the most expensive means of recruitment yet devised. Every Frenchman may be called to enter the army at the age of 20; but those who choose to enlist, as early as 18. He cannot again be called upon to serve. The term is for 5 years in the Regular Army, 4 in the Army Reserve, 5 years in the Territorial Army (Militia), and 6 in the Territorial Reserve. This brings the conscript to 40 years of age, when his liability to service ceases. The law of 1872 reorganizing the French army forbids the providing of substitutes by conscripts. An account is kept of the number of youths in France who reach the age of 20 in each year (about 280,000). All those are exempt from conscription who are under 5 feet 2 inches in height; or have any natural infirmities unfitting them for active service; or are the eldest of a family of orphans; or are the only sons of widows, or of disabled fathers, or of fathers above 70 years of age; or are intended for the Church; or are pupils at certain Colleges. Moreover, if two brothers are drawn as conscripts, and the younger is efficient, the elder is declared exempt; and if of two only brothers one is already in the army, or has retired through wounds or infirmity, the other is exempt. Culprits and felons are not allowed to enlist. The law of 1872 making military service obligatory on all Frenchmen (save in the above cases) has assimilated the French army system to that enforced in Prussia since 1813.

CONSTABLE.—Whether this officer was called originally *Comes Stabuli*—the Count of the Stable, or Master of the Horse (as alleged by Ducange)—or the *Koning Stapel*—Staff and Stay of the King (as Coke, Selden, and others, with less reason, have maintained)—the Constable, both in France and England, was a military personage of the very highest rank. The Constable of France rose gradually in importance from the comparatively modest position of an Officer of the Household, till at last he became, *ex officio*, the Commander-in-Chief of the army in the absence of the Monarch, the highest Judge in military offenses and in all questions of chivalry and honor, and the supreme regulator and arbitrator in all matters connected with tilts, tournaments, and all martial displays. The office of Constable is traced back by Anselme to Alberic, who held it in 1060; but the first Constable of France who appeared at the head of an army was Matthew, the Second Seigneur de Montmorency. The office was suppressed by Louis XIII. in 1626. Among the offices of the Ancient Monarchy which were restored by Napoleon for mere purposes of state, that of Constable was one. His brother, Prince Louis Napoleon, afterwards King of Holland, was created Grand Constable, the Vice-Constable being Marshal Berthier. The office was again abolished on the restoration of the Bourbons, and has not since been re-established. But besides the Constable of France, almost all the great vassals of the Crown had Constables who filled analogous offices at their minor Courts. There were Constables of Burgundy, of Champagne, and of Normandy; the latter of whom may be regarded as the progenitor of the Constable of England.

Shortly after the Conquest, a Lord High Constable of England appears, having powers and privileges closely corresponding to those of the Constable of France. His position as Judge of the Court of Chivalry, in conjunction with the Earl-Mareschal, and the limitation of his power, which followed, are explained under COURT OF CHIVALRY. The office was abolished by Henry VIII. on the attainder of Edward Stafford, Duke of Buckingham; and a Lord High Constable is now appointed only on the occurrence of great State Ceremonies, e.g., a Coronation. The High Constable of Scotland was an officer very similar to the Constable of France and England. After the Rebellion the offices of the Inferior Constables dependent on the High Constable, such as the Constable of the Castle, were abolished, but that of the High Constable himself was expressly exempted, and still exists in the noble family of Errol. The privileges attaching to this office are now entirely honorary; but in virtue of it, the Earl of Errol is said to be the first subject in Scotland after the Blood-Royal; and on the occasion of the visit of King George IV. to Edinburgh, the then Earl was allowed to take precedence of the possessors of all other hereditary honors. The present Earl of Errol is the twenty-second High Constable of Scotland.

CONSTABLE OF THE TOWER.—In England, a General Officer who has the chief superintendence of the Tower, and is Lord-lieutenant of the Tower Hamlets. He holds his appointment by letters-patent from the Sovereign, and is not removable at pleasure.

CONSTITUTION.—The following provisions of the Constitution relate to the land and naval forces: *Preamble*—We, the people of the United States, in order to * * provide for the common defense * * do ordain and establish this Constitution for the United States of America. Art. I. Sec. 1. All legislative powers herein granted shall be vested in a Congress of the United States, which shall consist of a Senate and House of Representatives. Art. I. Sec. 8. The Congress shall have power—*Clause* 1. * * To pay the debts and provide for the common defense and general welfare of the United States. * * *Clause* 9. * * To define and punish offenses against the law of nations. * * *Clause* 10. To declare war, grant letters of marque and reprisal, and make rules concerning captures on land and water. *Clause* 11. To raise and support armies; but no appropriation of money to that use shall be for a longer term than two years. *Clause* 12. To provide and maintain a navy. *Clause* 13. To make rules for the government and regulation of the land and naval forces. *Clause* 14. To provide for calling forth the militia to execute the laws of the Union, suppress insurrections, and repel invasions. *Clause* 15. To provide for organizing, arming, and disciplining the militia, and for governing such part of them as may be employed in the service of the United States, reserving to the States, respectively, the appointment of the officers, and the authority of training the militia according to the discipline prescribed by Congress. *Clause* 16. To exercise exclusive legislation * * over all places purchased, by consent of the legislature of the State in which the same shall be, for the erection of forts, magazines, arsenals, dock yards, and other needful buildings. *Clause* 17. To make all laws which shall be necessary and proper for carrying into execution the foregoing powers, and all other powers vested by this Constitution in the Government of the United States, or in any department or officer thereof. Sec. 9. *Clause* 2. * * The privilege of the writ of habeas corpus shall not be suspended, unless when, in cases of rebellion or invasion, the public safety may require it. * * Sec. 10. *Clause* 2. * * No State shall, without the consent of Congress * * keep troops or ships of war in time of peace * * or engage in war, unless actually invaded, or in such imminent danger as will not admit of delay. Art. II. Sec. 1. *Clause* 1. The executive power shall be vested in a President of the United States of America. * * Sec. 2. *Clause* 1. The President shall be Commander-in-Chief of the army and navy of the United States, and of the militia of the several States, when called into the actual service of the United States. * * Sec. 3. *Clause* 1. * * He shall take care that the laws be faithfully executed; and shall commission all officers of the United States. Art. III. Sec. 3. *Clause* 1. Treason against the United States shall consist only in levying war against them, or in adhering to their enemies, giving them aid and comfort. No person shall be convicted of treason, unless on the testimony of two witnesses to the same overt act, or on confession in open Court. *Clause* 2. The Congress shall have power to declare the punishment of treason; but no attainder of treason shall work corruption of blood, or forfeiture, except during the life of the person attainted. Art. IV. Sec. 4. *Clause* 1. The United States shall guarantee to every State in this Union a republican form of government; and shall protect each of them against invasion, and on the application of the legislature, or of the executive (when the legislature cannot be convened), against domestic violence.—*Amendments to the Constitution:* Art. I.—Congress shall make no law respecting an establishment of religion, or prohibiting the free exercise thereof; or abridging the freedom of speech or of the press; or the right of the people peaceably to assemble, and to petition the Government for redress of grievances. Art. II.—A well-regulated militia being necessary to the security of a free State, the right of the people to keep and bear arms shall not be infringed. Art. III.—No soldier shall, in time of peace, be quartered in any house without the consent of the owner, nor in time of war but in a manner to be prescribed by law. Art. V.—No person shall be held to answer for a capital or otherwise infamous crime, unless on a presentment or indictment by a grand jury, except in cases arising in the land or naval forces, or in the militia, when in actual service, in time of war or public danger; nor shall any person be subject for the same offense to be twice put in jeopardy of life or limb; nor shall be compelled, in any criminal case, to be a witness against himself, nor to be deprived of life, liberty, or property, without due process of law; nor shall private property be taken for public use without just compensation.

The power of making rules for the government and regulation of armies, as well as the power of raising armies, having in express terms been conferred on *Congress*, it is manifest that the President as Commander-in-Chief is limited by the Constitution to the simple command of such armies as Congress may raise, under such rules for their government and regulation as Congress may appoint. "The authorities [says Alexander Hamilton] essential to the care of the common defense are these: To raise armies; to build and equip fleets; to prescribe rules for the government of both; to direct their operations; to provide for their support. These powers ought to exist without limitation; because it is impossible to foresee or to define the extent and variety of national exigencies, and the correspondent extent and variety of the *means* which may be necessary to satisfy them." Defective as the present (old) Confederation has been proved to be, this principle appears to have been fully recognized by the framers of it; although they have not made proper or adequate provision for its exercise. Congress has an unlimited discretion to make requisitions of men and money; to govern the army and navy; to direct their operations. The government of the military is that branch of the code which embraces the military *Hierarchy*, or the gradual distribution of inferior authority. From this principle proceeds the localization of troops, their discipline, remuneration for important services, the repression of all infractions of the laws, and everything, in fine, which the legislature may judge necessary either by rules of appointment or promotion, penalties or rewards, to maintain an efficient and well-disciplined army. But, as if to avoid all misconstruction on this point, the Constitution not only declares that Congress shall make rules for the *government*, but also for the *regulation* of the army; and *regulation* signifies precise determination of functions, method, forms, and restrictions not to be departed from. It is evident, therefore, that the design of the framers of the Constitution was not to invest the President with powers over the army in any degree parallel with powers possessed by the King of Great Britain over the British army, whose prerogative embraces the *command* and *government* of all forces raised and maintained by him with the consent of Parliament; but their purpose, on the contrary, was to guard in all possible ways against executive usurpation by leaving with *Congress* the control of the Federal forces which it possessed under the Articles of the Confederation, and at the same time to strengthen the powers of Congress by giving that body an unrestricted right to *raise* armies, provided appropriations for their support should not extend beyond two years. The command of the army and navy and militia called into service, subject to such rules for their government and regulation as Congress may make, was given by the Constitution to the President; but the power of making rules of government and regulation is in reality that of Supreme Command, and hence the President, to use the language of the *Federalist*, in his relation to the army and navy, is nothing more than the "*First General and Admiral of the Confederacy;*" or the first officer of the military hierarchy with functions assigned by Congress. A curious example of this contemporaneous construction of the Constitution is found in a letter from Sedgwick to Hamilton. Congress, in raising a provisional army in 1798, created the office of Commander of the Army with the title of *Lieutenant General*. A year subsequently a provision was made by law for changing this title to that of *General*. This last provision gave great offense to Mr. Adams, then President, who considered it as an evidence of the desire of Congress to make "*A General over the President.*" So strangely was he possessed with this idea that he never commissioned Washington as General, but the latter died in his office of *Lieutenant General;* the President evidently thinking that the title of General conveyed a significancy which belonged to the President alone, although the Commander of the Army might in his opinion very properly take the title of *Lieutenant General*, and thus have his subordination to the Commander-in-Chief of the army and navy and militia clearly indicated. It is plain, therefore, no less from the appointment by the Constitution of the President as Commander-in-Chief, than from all contemporaneous construction, that his functions in respect to the army are those of First General of the United States, and in no degree derived from his powers as First Civil Magistrate of the Union. The advocates of Executive Discretion over the army must therefore seek for the President's authority in his military capacity, restrained as that is by the powers granted to Congress, which embrace the raising, support, government, and regulation of armies; for there can be no limitation of that authority which is to provide for the defense and protection of the community, in any matter essential to its efficacy; that is, in any matter essential to the *formation, direction,* or *support* of the National Forces. After the foregoing investigation of the unrestricted power of Congress in respect to the army, *save only in the appointment of the head of all the national forces, naval and military*, it will be plain that the 2d Section of the Constitution, in giving to the President the nomination and appointment, by and with the advice and consent of the Senate, of *all other officers* of the United States *whose appointments are not herein otherwise provided for, excludes* officers of the army and navy. The power of raising armies and making rules for their government and regulation necessarily involves the power of making rules of appointment, promotion, reward, and punishment, and is therefore a provision in the Constitution otherwise providing for the appointment of officers of the land and naval forces. So true is this that the principle has been acted on from the foundation of the Government. Laws have been passed giving to general and other officers the appointment of certain inferior officers. In other cases the President has been confined by Congress, in his selection for certain offices in the army, to particular classes. Again, rules have been made by Congress for the promotion of officers, another form of appointment; and in 1846 an army of volunteers was raised by Congress, the officers of which the Acts of Congress directed should be appointed according to the laws of the States in which the troops were raised, excepting the General Officers for those troops, who were to be appointed by the President and Senate—a clear recognition that the troops thus raised by Congress were United States troops and not militia. It is certainly true that the military legislation of the country has for long years vested a large discretion in the President in respect to appointments and other matters concerning the army; but it may well be asked whether fixed rules of appointments and promotion which would prevent the exercise of favoritism by the Executive might not, with the greatest advantage to the army and the country, be adopted by Congress? Military prejudices are not only inseparable from, but they are essential to, the military profession. The government which desires to have a satisfied and useful army must consult them. They cannot be molded at its pleasure; it is vain to aim at it. These are maxims which should lead Congress to the adoption of rules of appointment and promotion in the army which would prevent all outrages to the just pride of officers of the army. The organization of every new regiment, where the appointment of the officers has been left to Executive Discretion, shows that, if the desire has been felt in that quarter to cherish or cultivate pride of profession among the officers of the army, the feeling has been repressed by other considerations. All pride of rank has been so far crushed by this system of Executive Discretion that it is apparent, if Congress cannot provide a better rule for the government and regulation of the army, a generous rivalry in distinguished services must be superseded by political activity. Rules of appointment and promotion limiting the discretion of the President, and at the same time giving effect to opinions in the army, might easily be devised; or borrowed from existing rules in the French army, which, without ignoring the important principle of seniority, would at the same time afford scope and verge for rewards for distinguished services. No army can be kept in war in the highest vigor and efficiency without rewards for distinguished activity, and the appointment of Todleben at the siege of Sebastopol shows how far almost superhuman efforts may be prompted by investing a Commander in the field with the power of selecting his immediate assistants. Colonels of regiments with us now exercise this authority in selecting Regimental Adjutants and Quartermasters. Why should not the same trust be reposed in Commanding Generals of Departments, Brigades, Divisions, and Armies? And why should not all necessary restrictions (such as those in operation in the French armies) be put upon the President in making promotions for distinguished services, and also in original appointments, in order to secure justice to the army, and thereby promote the best interests of the country? See *Articles of War*.

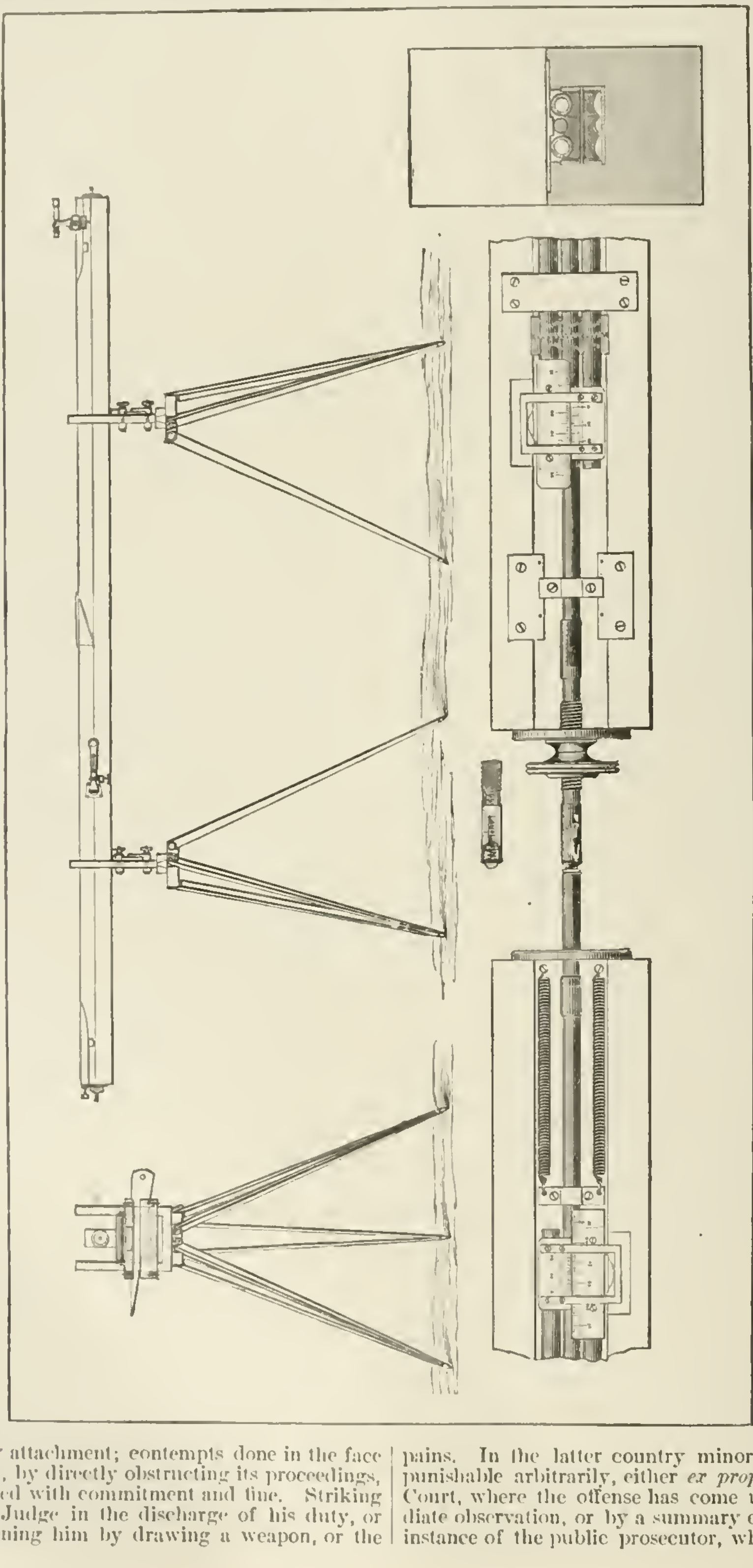
CONSULATE.—This supreme magistracy of the French Republic was established after the Revolution of the 18th Brumaire, and lasted to the Coronation of Napoleon. On the sudden overthrow of the Directory with the Constitution of the year III., the members of the Council of the Ancients and the Five Hundred, or rather those of them who approved of, or submitted to, that act of violence on the part of Bonaparte's grenadiers, appointed three Consuls—Sièyes, Bonaparte, and Roger Ducos. This approach to a monarchical government was confirmed, December 13, 1799, by the Constitution of the year VIII., by which Bonaparte was made First Consul, with Cambacérès and Lebrun as second and third; each was elected for ten years, and was re-eligible. The powers of the First Consul were made almost absolute. He promulgated the laws, appointed or dismissed Ministers, Ambassadors, Members of the Council of State, Military and Naval Officers, and all Civil and Criminal Judges, except Justices of Peace and members of the Court of Cassation. His income was fixed at 500,000 francs, and that of his inferior colleagues at 150,000 francs each. Bonaparte took up his residence at the Tuileries, and held a splendid Court. By Resolutions of the Senate, in May, 1802, Bonaparte was re-elected for ten additional years, and in August of the same year was made First Consul for life. In the appeal made to the nation, out of 3,577,259 votes, 3,568,885 were in favor of Bonaparte. The adulation of the Senate and people now knew no limit. Nothing but the imperial name and insignia were wanting to complete the picture of absolutism, and these were supplied May 18, 1804, when Napoleon was made Emperor.

CONTACT-LEVEL.—A valuable adaptation of the spirit-level for the production of exact divisions of scales, and generally for the determination of very minute differences of length. The device consists of a very delicate level pivoted at its middle and across its length, with a small tilt-weight at one end, which tips always in one direction. From the center of the level downward, a short rigid arm extends with a plain polished surface perpendicular to the chord of the level, and against which the contact is made. The carrier of this arrangement is either fixed, or mounted on a slide governed by a micrometer-screw. If now the end of a rod terminating in a hardened steel point be moved along horizontally till it bears against the contact-arm, the level will gradually assume the horizontal position, and the movement of the bubble as indicated by the scale upon the glass will depend upon the relation between the radius to which the level-tube is ground and the length of the contact-lever. If the latter is $\frac{1}{2}$ an inch long, and the radius of the glass tube is 400 feet (levels for astronomical purposes are ground to a sweep of 800 and 1000 feet radius), we have the relation between the lever and radius as 1 is to 9600; and as $\frac{1}{50}$ of an inch can readily be read from the level-scale, $\frac{1}{480000}$ of an inch will be the difference in length which each division on such a scale indicates. When it is remembered that such a determination of length can be repeated indefinitely, and that the readings are made without the aid of a magnifying-glass or artificial illumination, the perfection and beauty of the method will be appreciated.

CONTACT-SLIDE BASE APPARATUS.—This perfected apparatus, designed by Professor J. E. Hilgard, Superintendent of the United States Coast Survey, and represented on page 396, consists of two measuring-bars 4 meters long, exactly alike, and supported on trestles. The measurement is made by bringing these bars successively in contact, which is effected by means of a screw motion and defined by the coincidence of lines on the rod and contact-slide. Each bar consists of two pieces of wood about 8 by 14 cm. square and a little less than 4 meters long, firmly screwed together. Between the pieces of wood is a brass frame carrying three rollers, on the central one of which rests a steel rod about 8 mm. in diameter. On each side there is a zinc tube 9 mm. in diameter. The rod and tubes are supported throughout their length on similar systems of rollers. The zinc tubes form with the steel rod a metallic differential thermometer, and are so arranged that one tube is secured to one end of the rod, being free to expand in the other direction, the other tube being in a like manner fastened to the other end of the rod. The zinc tubes, therefore, with any change of temperature, expand or contract in opposing directions, and the amount by which the expansion of the zinc exceeds that of the steel is measured by a fine scale attached to the rod, while the zinc tube carries a corresponding vernier. The cut shows this arrangement, which is identical on both ends of the bars; a perforation in the wood of the bar allows this scale to be read. In addition to these metallic thermometers a mercurial thermometer is attached to the bar about midway of its length. The rods and tubes thus forming a united whole are lengthwise movable on the rollers by means of a milled nut working in threads cut on the steel rod, which passes through a circular opening in the brass plate screwed to the wooden bar, and against which the nut presses. Two strong spiral springs pull the rods back, and the nut is always pressed against the plate. One end of the rod is defined by a plain agate securely fastened to it; the other end carries the contact-slide, having an agate with a horizontal knife-edge. This slide is a short tube, fitting over the end of the rod, and pushed outward by a spiral spring. A slot in the tube shows an index-plate, with a ruled line fastened to the rod. To align the bars properly a small telescope is placed on each bar, and can be adjusted to bring the line of collimation over the axis of the rod. The trestle, shown in the upper left-hand corner of the illustration, consists of a strong tripod-stand, carrying a frame with two upright guides for two cross-slides, which are separated by a movable wedge. These cross-slides can be clamped in any position. By moving the wedge, the bar resting between the uprights is either elevated or depressed. To obtain smooth movements, friction-rollers are provided. To move the bars sideways, a coarse screw takes hold of a projection on the lower side of the bar, by turning which the bar can be moved laterally. There are three pairs of trestles, alike in construction with the exception that the upper slide of the trestle intended for the forward end of the bar carries a roller on which the bar rests, while the other has a fixed semi-cylindrical surface for the support of the bar. In making the measurement, the bars being four meters in length, the stands are set up at distances of two meters, each bar being supported at one fourth its length from the ends, as indicated by the painted black bands. Each bar has a sector with level alidade attached to one side, by which its inclination can be read off to single minutes.

CONTEMPT.—Any officer or soldier who shall use contemptuous or disrespectful words against the President of the United States, the Vice-President, against the Congress of the United States, or against the Chief Magistrate or Legislature of any of the United States in which he may be quartered, shall be punished as a Court-Martial shall direct. Any officer or soldier who shall behave himself with contempt or disrespect towards his Commanding Officer shall be punished by the judgment of a Court-Martial. No person whatsoever shall use any menacing words, signs, or gestures in presence of a Court Martial, or shall cause any riot or disorder, or disturb their proceedings, on the penalty of being punished at the discretion of the said Court-Martial. *Contempts* thus rendered summarily punishable by Courts-Martial are of public and self-evident kind, not depending on any interpretation of law admitting explanation or requiring further investigation. Courts-Martial sometimes act on this power. At other times individuals so offending are placed in arrest, and charges are preferred for trial. A Regimental Court-Martial may punish summarily, but are not competent to award punishment to Commissioned Officers. A Regimental Court-Martial in such cases would impose arrest. Citizens, not soldiers, would be removed from Court.

CONTEMPT OF COURT.—There is probably no country in which Courts of Law are not furnished with the means of vindicating their authority and preserving their dignity by calling in the aid of the executive, in certain circumstances, without the formalities usually attending a trial and sentence. Of this, the simplest instance is where a Judge orders the police to enforce silence, or to clear the Court. Contempts by resisting the process of a Court are in England punished by attachment; contempts done in the face of the Court, by directly obstructing its proceedings, may be visited with commitment and fine. Striking a Supreme Judge in the discharge of his duty, or even threatening him by drawing a weapon, or the like, has been an offense at common law in England of the highest kind since the times of the Anglo-Saxons; and in Scotland it is a statutory offense, punishable either capitally or by very severe arbitrary pains. In the latter country minor contempts are punishable arbitrarily, either *ex proprio motu* of the Court, where the offense has come under its immediate observation, or by a summary complaint at the instance of the public prosecutor, where, though not



Hilgard Contact-slide Base Apparatus.

committed in the immediate presence of the Court, it has relation to a matter which is, or has been recently, in dependence before it. See *Contempt*.

CONTEST.—An earnest struggle for superiority, defense, or the like; strife in arms. In a strictly military sense, to struggle to defend; as, the troops contested every inch of ground.

CONTINENTAL.—A term intended as the opposite of Provincial, assumed by the revolted American Colonies early in the War of the Revolution, an effort being made to induce Canada to join the Thirteen Colonies. Had the Canadians agreed, the whole of the Continent under English rule would have been in revolt. The first general representative body of the Thirteen Colonies was called the *Continental Congress*. See *Congress*.

CONTINGENT.—1. The quota of troops furnished to the common army by each member of an Alliance or Confederation of States. The word was especially applied to the proportions contributed by the several German States to the Army of the Confederation, which has given place to the Empire.—2. In the British service, the sum paid monthly to each Captain of a troop, company, or battery to defray the expense of stationery, the care of arms, and other minor demands.

CONTINUED LINES.—There are two classes of lines—*continued lines* and *lines with intervals*. Continued lines present no openings through which the enemy can penetrate except the ordinary outlets. Lines with intervals consist of detached works, which are inclosed partly, or entirely, throughout their perimeters, arranged in defensive relations with each other, and presenting wide intervals between them defended only by their fire. The same general principles apply to lines as to other field-works; but from their great extent they usually receive a slight relief, and the simplest angular figures are adopted for their plan. In laying them out, the Engineer should avail himself of all the natural features presented by the position, so as to diminish the labor of erecting artificial ones. See *Lines*.

CONTLINE.—The space between the strands on the outside of a rope. In *worming*, this space is filled up with spun yarn or small rope, which brings the rope thus treated to a nearly cylindrical shape, either to strengthen it or to render the surface smooth and fair for *serving* or *parceling*. See *Cordage*.

CONTOISE.—A flowing scarf worn with the earliest crests attached to the helm. It gave way to the *mantling*.

CONTOURING.—A term applied to the outline of any figure, and consequently to that of any section of a solid body; but when used professionally in connection with the forms of ground or of works of defense, the outline of a horizontal section of the ground or works is alone to be understood by it.

CONTRABAND OF WAR.—A name applied to certain commodities, or the rules relating to them, during hostilities between States which acknowledge what are called the Laws of Nations. One such law is that neutral Nations must not carry on, for the advantage of either of the belligerent powers, any branches of commerce from which they are excluded in time of peace. Another is that the name of Contraband of War shall be given to such articles as pertain to military or naval warfare—guns, ammunition, and stores of all kinds. Unless there are special treaties, defining exactly what articles are contraband of war, the interpretation of this law often leads to much embarrassment. Another law insisted on by England during the last great war was that each belligerent shall have a right to visit and examine neutral ships, to see whether they carry any articles which are contraband of war, and which seem likely to be intended for the enemy. A neutral State may carry on ordinary trade with either belligerent, except when prevented by blockade; but the ships, according to the above rules, must not contain articles contraband of war; nor must a conterminous land-frontier be crossed by such commodities. If a merchant evades these rules, he does so at his own risk; his merchandise may be seized, and his own Government will not protect him. By the law and practice of Nations it is for the Admiralty Court of the capturing power to decide what is or what is not contraband of war. Upon such questions it is the province of this Tribunal to adjudicate; and from its final judgment there is no appeal. At various times discussions have arisen whether corn, hay, or coal can ever be included in the list of articles contraband of war; they are manifestly articles of peaceful commerce, but they are also essential to the maintenance of an army, and sometimes a supply would give one belligerent a great advantage over the other. Especially is this the case in reference to coal, in the present age of war-steamers.—Contraband in commerce depends, however, upon the special laws of each country.

CONTRACTION.—1. The state of being drawn into a narrow compass, or of becoming smaller. In horses' feet it is brought on from bad shoeing, hot stables, or confinement. The foot becomes oblong instead of round. The remedy to be applied should be thin sole and quarters, and the feet kept moist; also tips or spring shoes, tar or hoof ointment.

2. All solid bodies contract their size in the operation of cooling. It follows, therefore, that if the different parts of a body cool unequally they will contract unequally, and the body will change form, provided it be not restrained by the presence of a superior force; if it be so restrained, the contractile force will diminish the adhesion of parts by an amount which depends on the rate of cooling of the different parts, and the contractibility of the metal. This is an important consideration in estimating the strength and endurance of cannon, particularly those made of cast-iron, as will be seen by examining the form of the casting and the method of cooling it. The general form of the casting is that of a solid frustum of a cone; it is therefore cooled from the exterior, which causes the thin outer layer to contract first, and force the hotter and more yielding metal within toward the opening of the mold. Following this, the adjacent layer cools and tends to contract; but the exterior layer, to which it coheres, has become partially rigid, and does not fully yield to the contraction of the inner layer. The result is, the cohesion of the particles of the inner layer is diminished by a force of extension, and that of the outer layer increased by a force of compression. As the cooling continues, this operation is repeated until the whole mass is brought to a uniform temperature; and the straining force is increased to an extent which depends on the size and form of the mass, the rapidity with which it is cooled, and the contractibility of the particular metal used. All cannon, therefore, that are cooled from the exterior are affected by two straining forces—the outer portion of the metal being compressed, and the interior extended, in proportion to their distances from the *neutral axis*, or *line* composed of particles which are neither extended nor compressed by the cooling process.

The effect of this unequal contraction may be so great as to crack the interior metal of cast-iron cannon, even before it has been subjected to the force of gunpowder; and chilled rollers, which are cooled very rapidly by casting them in iron molds, have been known to split open longitudinally, from no other cause than the enormous strains to which they are thus subjected. The strain produced by the action of a central force, as gunpowder acting in a cannon, is not distributed equally over the thickness of metal. Barlow shows *that it diminishes as the square of the distance from the center increases.* It follows from this that the sides of a cannon are not rent asunder as by a simple tensile force, but they are torn apart like a piece of cloth, commencing at the surface of the bore. This is confirmed by experience; for the inner portion of the fractured surface of a ruptured gun is found to be stained with the smoke of the powder, while the outer portion is untouched by it. It will thus be seen that the effect of ordinary cooling is to diminish the strength and hardness of the metal of cannon at or near a point where the greatest strength and hardness are required, i.e., at the surface of the bore.

The strains produced by unequal cooling increase with the diameter of the casting and the irregularity of its form. This explains the great difficulty which is encountered in making large cast-iron cannon proportionally as strong as small ones; and also how it is that projections like bands, moldings, etc., injure the strength of cannon. It also explains why cannon made of "*high*" cast-iron, or cast-iron made more tenacious by partial decarbonization, are not so strong as cannon made of weaker iron; for it is well known that such iron contracts more than the latter in cooling, and therefore produces a greater strain of extension on the surface of the bore. The foregoing considerations led Captain Rodman to propose a plan for cooling cannon from the interior, hoping thereby to reverse the strains produced by external cooling, and make them contribute to the endurance rather than to the injury of the piece. The method employed is to carry off the internal heat by passing a stream of water through a hollow core, inserted in the center of the mold-cavity before casting, and to surround the flask with a mass of burning coals to prevent too rapid radiation from the exterior. Extensive trials have been made to test the merits of this plan; and the results show that cast-iron cannon made by it are not only stronger but are less liable to enlargement of the bore from continued firing. Indications were shown, however, in these and in other trials, that the strains produced by unequal cooling are modified by time, which probably allows the particles to accommodate themselves, to a certain extent, to their constrained position, as in the case of a bent spring or hoop. See *Cooling*.

CONTRACTS.—All purchases and contracts for supplies or services for the military and naval service are made by or under the direction of the chief officers of the Departments of War and of the Navy, respectively. And all agents or contractors for supplies or services as aforesaid render their accounts for settlement to the accountant of the proper department for which such supplies or services are required, subject, nevertheless, to the inspection and revision of the officers of the Treasury. Contracts for subsistence supplies for the army, made by the Commissary General, on public notice, provide for a complete delivery of such articles, on inspection, at such places as shall be stipulated. The Quartermaster's Department of the Army, in obtaining supplies for the military service, states in all advertisements for bids for contracts that a preference shall be given to articles of domestic production and manufacture, conditions of price and quality being equal, and that such preference shall be given to articles of American production and manufacture produced on the Pacific coast, to the extent of the consumption required by the public service there. In advertising for army supplies the Quartermaster's Department requires all articles which are to be used in the States and Territories of the Pacific coast to be delivered and inspected at points designated in those States and Territories; and the advertisements for such supplies are published in newspapers of the cities of San Francisco, in California, and Portland, in Oregon. Contracts are not made at posts unless specially ordered, and are not so ordered unless the stores required can be procured at such posts as economically as if sent from other markets or from depots; and all such contracts are made out in the name of and signed by the chief officer of that branch of the Staff of the command to which they pertain. Whenever practicable, contracts for supplying military posts with fuel, forage, straw, etc., provide for delivery, monthly, of the quantities required each month, in order to avoid unnecessary accumulation of property at posts, and to distribute expenditure therefor throughout the year, and to prevent risk of great loss by fire or other cause.

Except in the rare cases where the United States may elect to exercise its reserved right to reject proposals, contracts are awarded to the lowest responsible *bona-fide* bidder, who, when required, produces a proper article, and whose proposal therefor is not unreasonable in amount. The following is the Form of a General Contract:

Articles of agreement entered into this —— day of ——, eighteen hundred and ——, between ——— ———, United States Army, of the first part, and ——— ———, of the county of ——, State of——, of the second part: This agreement witnesseth, That the said ——— ———, for and in behalf of the United States of America, and the said ——— ———, for ——— ———, —— heirs, executors, and administrators, have mutually agreed, and by these presents do mutually covenant and agree, to and with each other, as follows, viz.: [Here give the name of the contractor, and state what he agrees to do by introducing in succession those articles of the agreement which define his duties; such, for instance, as fix the place and date of delivery of the supplies or performance of the services; as give the quantity, quality, and description of the supplies to be furnished, character of their packages, etc., or nature of the service to be rendered; all in such detail as may be requisite. Also here insert those articles which relate to terms of payment; the action to be taken by the United States in case of failure or deficiency on the part of the contractor; and any other conditions which should be embodied in a contract stipulating for the delivery of supplies or for the performance of a service.] No member of or delegate to Congress, nor any person belonging to, or employed in, the military service of the United States, is or shall be admitted to any share or part of this contract, or to any benefit which may arise herefrom. [*Here add, to any contract made with an incorporated company for its general benefit, the following words, viz.: "But this stipulation, so far as it relates to members of or delegates to Congress, is not to be construed to extend to this contract."*] This contract shall be subject to approval of [*name the proper officer*]. In witness whereof, the undersigned have hereunto placed their hands and seals the date first herein before written.

Witnesses:

——— ———. ——— ———. [L. S.]
——— ———. [L. S.]
——— ———. ——— ———. [L. S.]

(Executed in quintuplicate.)

Approved: ———, 18—.

——— ———.
—— *Commanding* ——.
——— ———.
——— ———.

Approved: ———, 18.

——— ———,
—— *Commanding* ——.
——— ———.
——— ———.

I do solemnly swear that the foregoing is an exact copy of a contract made by me personally with ——— ———; that I made the same fairly without any benefit or advantage to myself, or allowing any such benefit or advantage corruptly to the said ——— ———, or any other person; and that the papers accompanying include all those relating to the said contract, as required by the statute in such case made and provided.

——— ———,
—— ——.

Subscribed and sworn to before me this —— day of ——, eighteen hundred and ——.

——— ———,
—— ——.

No contract is entered into on the part of the United States unless the contractor, upon the execution of the contract or as soon thereafter as practicable, furnishes a bond according to the form prescribed. Execution of bonds may be waived when the contract involves no greater sum than five hundred dollars in value. The amount of the penalty of the contractor's bond is not less than one tenth of, nor more than the full sum of, the total consideration of the contract; the amount to be fixed, in each case, by the officer representing the United States. The Form of the Contractor's Bond is as follows:

Know all men by these presents, That we [*name of obligor*], of [*residence of obligor, giving town, county, State, etc.*], as principal, and [*name of surety*], of [*residence of surety*], and [*name of surety*], of [*residence of surety*], as sureties, are held and bound unto the United States of America in the penal sum of —— dollars, to the payment of which sum, well and truly to be made, we do bind ourselves, our heirs, executors, and administrators, jointly and severally, firmly by these presents.

Given under our hands and seals this —— day of ——, 18—.

The condition of this obligation is such that, Whereas the above-bounden [*name of obligor*], has, on the —— day of ——, 18—, entered into a contract with [*name and description of officer*], for [*here set forth in brief the subject of the contract*]:

Now, therefore, if the above-bounden [*name of obligor*], ——

heirs, executors, and administrators, shall and will, in all respects, duly and fully observe and perform all and singular the covenants, conditions, and agreements in and by the said contract agreed and covenanted by ——— ——— to be observed and performed, and according to the true intent and meaning of the said contract, and as well during any period of extension of said contract that may be granted on the part of the United States as during the original term of the same, then the above obligation shall be void and of no effect; otherwise to remain in full force and virtue.

Witnesses:

——— ———. ——— ———. [L. S.]
——— ———. ——— ———. [L. S.]
——— ———. ——— ———. [L. S.]

(Executed in duplicate.)

The sureties are to make and subscribe affidavits of justification on the back of the bond; the sum in which they jointly justify to be double the amount of the penalty; the affidavit to be taken before any official or person authorized or permitted by the laws of the United States, State, Territory, or District, to administer oaths.

The justification is, if practicable, followed by the certificate of a Judge of a United States Court or United States District Attorney, or, in their absence, by some other civil official of the United States, who certifies that the sureties are known to him, and that, to the best of his knowledge and belief, each is pecuniarily worth, over and above all his debts and liabilities, the sum stated in his affidavit of justification. But, if necessary or more convenient, separate certificates may be furnished as to each surety. See *Proposals*.

CONTRACT-SURGEONS.—In the United States army, these are physicians employed from civil life, at a specified compensation, to perform the duties required of Commissioned Medical Officers, when for any reason the number of the latter is insufficient. While they have no rank, they still have the allowances of an Assistant Surgeon, and are entitled to the same protection in their positions, also to the same respectful subordinate conduct and to the same military courtesy from enlisted men, as if they were Commissioned Officers. They are placed in the position of Commissioned Officers, so far as relates to their duties as Surgeons, by the Government. Surgeons from civil life who tender their services for the benefit of the sick and wounded in the field, under the invitation of the Secretary of War, are each allowed transportation to and from the place where their services may be needed, and, while so employed, the use of a public horse, a tent, and the privilege of purchasing subsistence stores from the Subsistence Department. See *Acting Assistant Surgeons*.

CONTRAMURE.—In fortification, a wall erected before another partition-wall to strengthen it, so that it may receive no damage from the adjacent buildings.

CONTRAVALLATION.—A name sometimes given to a belt of field-works thrown up around and facing the place invested, to render the besiegers secure against surprise. See *Countervallation*.

CONTREFORTS.—Brick-work which is added to the revetment of a rampart on the side of the terre-plein, and which is equal to its height. Contreforts are used to support the body of earth with which the rampart is formed. They are likewise used in the revetments of counterscarps, in gorges, and demi-gorges, and frequently form a part of the construction of the powder-magazines, which are bomb-proof. See *Counterfort*.

CONTRIBUTION.—In a military sense, an imposition or tax levied on the people of a conquered town or country.

CONTROL DEPARTMENT.—One of the Civil Departments of the British army, having for its object an efficient and economical control over the Departments it supervises. It may be said without exaggeration to be one of the most important Departments, for on it depends the custody and supply of all stores, whether of food or ammunition, the provision of transport, etc. It takes the place of what was formerly the Commissariat Department, in addition to other duties, such as were formerly in the hands of the Quartermaster General. Without the thorough efficiency of this Department no army can exist in the field; failure would probably entail defeat and all the disasters attending such a calamity. We have an instance in the Franco-Prussian War of the disasters likely to occur to an army whose Commissariat is unequal to the demands upon it. Take the case of the French army at Sedan, which, it is said, from want of proper Commissariat arrangements, was one of the causes that prevented it from effecting the relief of Metz, and was consequently overwhelmed by the Prussian army. The Control, as at present organized, is comparatively a new Department. The history of its formation is to be found in the various Blue Books on the subject, dating back to 1859; but it was in the year 1870 that the Department was consolidated, and divided into three administrative ranks, namely: Controller's, ranking with a Major General; Deputy Controller's, ranking with a Colonel; Assistant Controller's, ranking with a Lieutenant Colonel; and two Executive Sub-Departments—(1) *Supply and Transport*, which include the issue and account of stores and provisions, superintend and direct all transport, officer and command the Army Service Corps; and (2) *Pay*. For the management of the Supply and Transport, three Commissaries are attached who command the Army Service Corps, and who rank as follows: Commissary, with Major; Deputy Commissary, with Captain; Assistant Commissary, with Lieutenant. For the duties of the Pay Department there are three grades of officers, viz., Paymaster, Deputy Paymaster, and Assistant Paymaster, ranking in the same position as stated for Commissaries. First appointments in the executive branches of the Control Department are conferred on Civilians selected by competitive examination, or on Subalterns of the army and well-deserving Non-commissioned Officers. The limit of age is 17 to 20 for Civilians, 22 for Subalterns of the army and militia. In the regulations of 1870 for the Control, it will be found that the first ten paragraphs relate to general duties of the Department, and 11 to 18 lay down the duties of Control Officers towards the General Officer Commanding. These instructions show that the Control Officer is independent of the General in Command, in being able to communicate direct with the Secretary of War—which means that the Control Department is under the War Office, instead of the Commander-in-Chief, which appears to be a mistake. On this point most military men are in accord, and there is in *Blackwood's Magazine* for October, 1874, a very good article on the subject of the Control Department, showing its unsuitableness, as at present constituted, either for war or peace. The article is written by a General Officer of great experience, General Lysons; it is full of good sense and military knowledge, and may be taken as the view entertained by most military men who have passed their lives in the field. A return to the old organization of the Commissariat Department seems to be demanded, and will doubtless be reverted to before long: it was sound and good; it stood the test of years of practical experience; it grew under the hard hand of necessity; it carried the army through all the difficulties of the Peninsular War, and led the troops to victories the most brilliant in the annals of history. Many officers think it unadvisable to mix up, in one Department, supply, store, passage transport, and half a dozen other things, each of which should be a Department of itself. To crowd Department upon Department under one head, and to expect efficiency, is simply courting failure. On the formation of the Control, the following separate branches of the army were amalgamated with it, viz.: Commissariat; Barracks; Military Stores; Purveyor's; Army Transport—then known as the Military Train, to which a large number of civil and military employés were also attached, dispersed in a variety of Sub-Departments, having no connection with each other. The Control Department is presided over by a Surveyor General of Ordnance at the War Office, who has under him a Director of Transport and Supplies, and a Director of Military Stores. The administrative branch consists as is shown above.

CONTROLLER.—An officer whose duty it is to keep financial accounts, or to see that they are properly kept and audited. In the United States Treasury Department there are the First and Second Controllers to examine accounts and sign drafts; and also a Controller of the Currency, who furnishes circulating notes to banks. In some of the States, as New York, a Controller is elected by the people who has general charge of the financial affairs of the State. There is also a Controller in the city of New York, elected by popular vote. In the British service, the Controller is the highest grade in the Control Department. He ranks with a Major General.

CONVALESCENT.—A soldier discharged from hospital, but who is not strong enough to do his duty.

CONVALESCENT-HOSPITAL DEPOTS.—Encampments of huts or tents for the reception of men discharged from the general hospital, and who require no longer medical attendance, but at the same time are not fit to join the ranks, from a want of strength. Such depots relieve the general hospital, and are better places for the convalescent than a crowded sick-room, as they are removed from a bad atmosphere, and have consequently a favorable chance of gaining strength. As regards hospitals, the Medical Departments is responsible for the use of all stores, and for timely requisitions, but the Control Department is responsible for such stores being supplied.

CONVENTION.—An agreement entered into by troops which are opposed to one another, either for the suspension of hostilities or the exchange of prisoners. See *Truce.*

CONVERSION.—1. A term used in ordnance nomenclature when condemned stores are converted or turned into use for other purposes. The term is made use of when smooth-bore guns are converted into rifled guns.—2. A change of front, as of a body of troops attacked in the flank.

CONVERTED GUNS.—A term applied to cast-iron guns lined with wrought-iron or steel tubes. The coils for the tubes are made entirely of wrought-iron bars, specially prepared by being put three times through roughing-rolls; puddled iron is hard and brittle and is not by itself suitable for guns. A sufficient number of bars are piled or faggoted together to form a bar of the size it is intended to roll. The pile, composed partly of puddled iron and partly of scrap, the former being placed always on the outside, on account of the more even surfaces, is raised to white heat and rolled into a long bar about 24 feet long, and varying in section from 2¼ to 7 inches, according to the purpose for which it is intended. It is then cut into lengths, again faggoted, raised to a welding heat and passed between the rollers; one rolling may be sufficient. The section of the bar is slightly trapezoidal, in order that when the hot bar is wound round the mandrel, narrow side inward, the spreading of the inside and the narrowing of the outside may be neutralized, and no space left between the folds of the coils. To weld the bars together, the ends must be scarfed down and placed from opposite sides in a furnace, from which, when they arrive at a white heat, they are withdrawn and welded under an adjacent steam-hammer, sand having been thrown on the hot bars (as is indeed customary in the case of all forgings) in order to clean the surface and prevent scale forming, by converting the superficial oxide into a liquid silicate which will flow off of its own accord or be squeezed out by the hammer. Another bar is welded on in a similar manner, and so on until a sufficient length is obtained for the required coil.

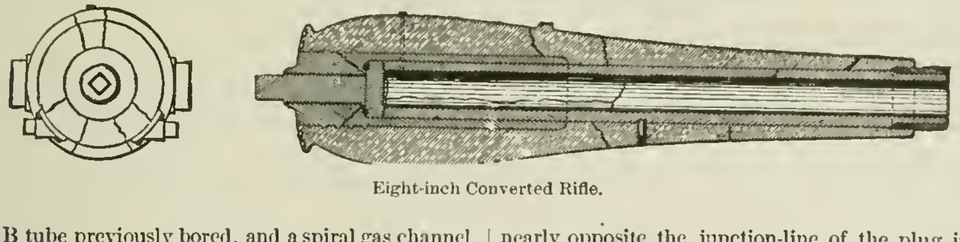
The bar to be coiled, having the ends flattened down, is placed on trestle-rollers in front of a long reverberatory furnace with a chimney at the far end and grates along its sides. A chain being hooked into an eye or hole in the end, the bar is drawn by machinery into the furnace. When the bar arrives at a bright-red heat, the end near the door is drawn out by means of the same eye, and is attached to a pin, this end being cooled with water to prevent it tearing away with the weight of the bar; this pin is connected with a slightly tapering iron roller or mandrel fixed across and in front of the door of the furnace; the mandrel tapers in order to facilitate the removal of the finished coil. The apparatus is then put into gear, and the mandrel revolves, winding the bar around it. During the process scales form between the folds, but their effect is almost nullified by subsequent heating and forging, sand being used to assist in liquifying the oxide as stated above. When the coil is formed, the fixed extremity is hammered off the pin and water is poured on that end to cool it, in order that the folds there may not be opened out in taking off the coil. If the coil is large, a short iron bar is placed with one end resting on the ground and the other end against the extremity which has been removed from the pin. The mandrel is then turned in the same direction as that in which it revolved when the coil was being formed, and the coil, being prevented from revolving by the iron prop, is loosened and slips down toward the narrow end of the mandrel. The mandrel is then lifted up by a crane and the coil drops off.

For the welding, which, especially in tubes for lining guns, must be done with great care, the coil is placed upright in a reverberatory furnace, for were it placed on its side it should be turned over in order to be equally heated all through, and moreover drippings from the fire-brick which line the furnace would probably drop from the roof in between the folds. The tube being intended for an inner one, two furnaces have to be used; one is at a low temperature, (termed a blue light), and when the coil arrives at a red heat it is brought out and transferred to the other, where it is brought to a welding heat. This is found to be more economical than by placing the cold coil at once into a very hot furnace, and also prevents any injury to the iron which would result from so doing. In all cases of welding it is necessary not only to strike while the iron is hot, but that the surfaces to be joined should be perfectly clean; the white hot coil is therefore transferred from the furnace to the steam-hammer as quickly as possible, not neglecting to throw sand upon it. The coil is first placed vertically under the hammer, and receives a few smart blows to weld the folds; it is then thrown on its side, and being gradually turned, is hammered (or patted) all round to straighten it. It is then raised vertically again and a punch or mandrel rather over half the length and a little larger than the interior diameter of the coil is hammered down its own length; the coil is next placed on its side and hammered round, that half of its length thus being made very compact and large enough to let the mandrel fall out; after this the coil is again raised vertically, and the mandrel is forced in the opposite end, and the process repeated. The mandrels are of coiled iron and very hard. The reason why a long mandrel is not forced through the whole length of the coil is that it would tend to separate the folds.

The coil is replaced in the furnace for a second heating, and much the same process is followed to render the ring more consolidated as well as more shapely; a fine mandrel is also used to make the interior more perfect; and in order to prevent the tube from being bell-mouthed, a flexible steel bar is used under the hammer to flatten the ends. Before the coil is removed from the hammer, water is thrown over it, which, forming into steam, blows off the black scales and shreds where the work is good, but a black spot is left by the water if there is a bad part. In order to form lining-tubes, several of these coils have to be united. To weld them together, the coils have to be faced (turned smooth at the ends) and reciprocally recessed; that is, a projection (spigot) is formed at one end of a coil, while a recess (faucet) is bored in the corresponding end of another coil. The height of the shoulder is a little greater than the depth of the recess, in order that a close joint may be obtained on the interior. The recess is then expanded by heat and shrunk over the projection, so that the two coils are attached securely enough together to admit of their being put into the furnace for welding. For the inner barrel, which is intended to be the entire length of the bore, the tube is put crossways through a furnance so constructed that intense heat acts on the joint while the remote ends project outside. When the joint arrives at a welding heat, a stout iron bar is passed right through the tube; this bar is keyed at one end, and by means of a screw-nut, worked by a long lever at the other end, the two coils are pressed and thus welded together. This pressure slightly bulges the metal at the junction, so it must be straightened under a steam-hammer. Another coil is then added on in a similar manner, and so on until the tube is of the required length.

The tube, if for an 8-inch rifle, after having its necessary length, is then rough and fine bored to about 7.92 inches diameter, and the recess in the breech cut and tapped for the wrought-iron cup. The cup for closing the breech-end of the barrel is forged and stamped into shape under the steam-hammer. It is turned inside and outside, and furnished on the outside with a thread of four or five to the inch. It is then screwed tightly home. The tube in this state is proved with water-pressure of 120 pounds to the square inch, to ascertain that the cup fits tightly and that there is no leakage. The breech-end of the A tube is then turned over a length of 40 inches for amount of extension, in fact, as that due to its elastic limit or pressure of 12 tons to the square inch of section). Therefore it is not necessary to have more than 500° F., which will allow a good working margin. With respect to the mode of cooling during the process of shrinking, care must be taken to prevent a long coil or tube cooling simultaneously at both ends, for this would cause the middle portion to be drawn out to an undue state of longitudinal tension. Therefore, in some cases, water is projected on one end of a coil so as to cool it first. In order to prevent the expansion of the inner tube, thus obstructing or retarding the operation of cooling, water is circulated through the interior by means of the usual supply-pipe and siphon. In the manufacture of these tubes, samples of each week's work are tested for tensile strength and elasticity, and usually with most favorable results; the stretching-weight being about 12 tons, and the breaking-weight 23 tons, per square inch.

Before inserting the coiled wrought-iron barrels, the cast-iron gun should be bored out to the required size and the bore afterwards carefully adjusted by lapping with leaden block and sand and water. The taper, if any, from the breech toward the muzzle, should be uniform, and in no place should the eccentricity exceed .002 inch. The muzzle-end should be screwed with an allowance of .015 between the diameters of the ring and the gun; the screwed part should be longer than required for the ring, so as to insure the rear end of barrel being in contact with the cast-iron at the end of the bore. A "gas-indicator hole" is drilled through the breech-end, so that it will come



Eight-inch Converted Rifle.

the B tube previously bored, and a spiral gas channel, .05 inch deep and .1 inch wide, is cut round its exterior, communicating with the star grooves cut in the end of the barrel and the gas-escape through the cast-iron breech.

The B tube consists of two coils united, and being rough-turned to a diameter of about 13.75 inches, and finished-bored to 10.75 inches, it is shrunk on with .003 inch shrinkage in the diameter. The B tube in order to be shrunk on the A tube has to be bored to that degree of smoothness which is necessary for close contact and mutual support, and is gauged to $\frac{1}{1000}$ of an inch every few inches of its length as well as at every shoulder it may have. To these measurements the shrinkage is added, and a plan made out according to which the exterior of the inner coil or A tube must be fine-turned in order that it may exceed in diameter the bore of the outside coil by the required amount of shrinkage at the respective points. This plan, together with a series of corresponding "horseshoe" gauges (very accurately adjusted), is then furnished to the turner, who turns down the inside coil to the proper size. The operation of shrinkage is very simple. The outer coil is expanded by heat until it is sufficiently large (if a large mass, by means of a wood-fire, for which the tube itself forms the flue; if a small mass, in a reverberatory furnace at a low temperature). It is then raised up by a traveling crane overhead, and dropped over the part on to which it is to be shrunk, which is placed vertically in a pit ready to receive it, and where the tube and jacket cool off. The heat required in shrinking is not very great. Wrought-iron, on being heated from 62° F. (the ordinary temperature, say) to 212°, expands linearly about $\frac{1}{1000}$ part of its length (the same nearly opposite the junction-line of the plug in the barrel. All sharp edges in the interior of the gun should be taken off, and the bore carefully cleaned and oiled. The barrel is turned to the measurements taken from the gun when finally prepared to receive the barrel. These measurements should be taken at least every 6 inches from the muzzle to within 12 inches from the breech, when they should be taken at every inch. From the muzzle to a point 24 inches from the breech, the difference between the bore and the size of the barrel should not exceed .015 of an inch, and from thence to the bottom of the bore .007 of an inch.

The barrel can be turned by means of an expanding mandrel placed in the muzzle, the center being left in the plug at the bottom of the barrel. The reduced part for the muzzle-ring should be .01 of an inch less in diameter than the bore of the ring; the breech of the ring should be square to the face against which it is screwed. The radius at the breech-end of barrel should not be in contact with the casing, but should have .05 of an inch clearance; thus if the gun has been bored out with a 1.7 radius tool, the barrel should be turned to 1.75 inch radius. When fitting the barrel into the gun, all bearing-surfaces should be well oiled. It is most convenient to place the gun on trestles about 3 feet 6 inches high. The barrel is lifted by a crane and entered as far as the slings will permit. The slings are then placed round the end of the expanding mandrel, and at the outer end of the mandrel are bolted two strong cross-bars by which the barrel is worked round while it is being drawn in by the crane. The indicator-hole allows the air to escape. The plug-center should not be taken off until it comes in contact with the bottom of the bore, when it may be turned off and the breech-end well marked with thin red-lead paint. The barrel should then be again tried in and well worked against the casing, great care being taken that the end of the barrel abuts truly against the bottom of the bore. A small screw is inserted at about the middle of the length of the barrel, to prevent the possibility of the barrel turning round in the gun during firing. When the tube is properly adjusted, the collar is securely screwed into the muzzle. The muzzle of the gun is then faced, and the bore lapped and rifled. The old vent is closed with a wrought-iron screw-plug, a new vent (copper-bushed) being placed nearer the muzzle.

The drawing represents an 8-inch converted rifle, tested with the following results: Six preliminary rounds were fired, using charges ranging from 20 to 30 pounds. Four hundred and fifty rounds were fired with battering-charges of 35 pounds of hexagonal powder and an average weight of projectile (Butler) of 171 pounds. All examinations up to the one hundred and seventieth fire failed to discover any evidence of injury to the system; but impressions taken of the bore at this round showed a fine line extending from the commencement of the land immediately in front of the vent to the copper bushing. This proved to be an initial rupture, as at 175 rounds a crack had developed from the vent to the muzzle in and through the tube. The firings were continued from this point up to the four hundred and fifty-sixth (the breaking round), making a total of 286 rounds which the system endured after the rupture of the tube. The gun was fired after the complete rupture of the inner tube—at the one hundred and seventy fifth round—to test how long the jacket and the cast-iron casing would stand battering-charges. Evidence of rupture of the jacket was noted at the last few rounds, and the gun, when burst, evidently was being held together by a weakened cast-iron casing, probably cracked on its interior surface. The steel in both jacket and tube, although of good quality, was evidently too high and inextensible to secure the very best results.

An analysis of the record shows as follows: A mean initial velocity of 1379 feet, using 35 pounds powder and projectile of about 185 pounds; the mean maximum pressure being 30,453 pounds per square inch, and, for a shot of 170 pounds, a velocity of 1425 feet, and a corresponding mean maximum pressure of 29,622 pounds. Forty-six shots of about the weight of the former, and 283 shots of about the weight of the latter, were fired. The mean weight of all projectiles—using 35-pound charges—is 171 pounds; the mean velocities and pressures obtained are respectively 1419 feet and 29,668 pounds. No anomalies are apparent in these respects, and the record shows a general accordance with the results attained in other trials. The star-gauging at the one hundred and seventieth round indicated a maximum enlargement of .010 inch; at the one hundred and seventy-fifth round, of .0115 inch, the result of the crack; from this point to the four hundred and fifty-second round the maximum enlargement was .0235 inch. The gutta-percha impressions taken at various times during the progress of the trial indicated no special erosion from the gases; but, as the firings progressed, spawls were gradually developed along the line of the crack in the tube. See *Breech-insertion, Coiled Tubes, Fabrication of Tubes, Ordnance, Palliser Gun,* and *Parsons Gun.*

CONVERTER.—In metallurgy, a receptacle holding iron which is to be converted into steel; a spherical vessel lined with fire-clay, the bottom having numerous holes through which a powerful blast is driven during the process. From this vessel the liquid steel is poured into molds. See *Blistered Steel.*

CONVERTING.—1. Decarbonizing, or changing cast-iron into steel. 2. A name applied to changing muzzle-loading arms to breech-loaders, and which in some form has taken place with the small-arms of most national armaments. From among the various competing plans for converting the Enfield rifle of the English service into a breech-loader, that of Snider was adopted. The cost of conversion is about 15s. English for each rifle. The method is as follows: About two inches of the barrel are cut away at the breech, and a solid breech-stopper working sideways on a hinge is placed in the opening thus made. Through this stopper passes a piston, one end of which, when the breech is closed, receives the blow from the hammer, while the other communicates it to the center of the cartridge, thus firing the latter. The empty cartridge-case is retracted after each discharge by means of sliding back the stopper on its pintle, when the tilting of the piece tips out the shell and another can be inserted. The Springfield rifle is also converted into a breech-loader. See *Converted Guns.*

CONVEX ORDER OF BATTLE.—If an attack is made in the center of the enemy's line, refusing both wings, the general direction of the line of battle of the attacking army will be convex towards the enemy's line. This order of battle has been frequently used, and possesses the advantage of producing great results when the attack is successful. It possesses the disadvantage of selecting as a point of attack the strongest part of the enemy's line, and in case of repulse the failure is apt to be followed by great disaster if the enemy makes a vigorous counter-attack. See *Concave Order of Battle.*

CONVOY.—To conduct a convoy in safety through an enemy's territory, where it is exposed to attacks either of regular or of partisan troops, is one of the most hazardous operations of war; owing to the ease with which a very inferior force may take the escort at disadvantage in defiles, or other positions favorable to an ambuscade or surprise, and to the difficulty of securing a long column, like that presented by a convoy, from a sudden attack.

The escort should be of sufficient strength to beat off any presumed force that the enemy can bring against it. A weak escort will only hold out a temptation to the enemy to attack the convoy. When the convoy is of very great importance, it may be necessary, besides giving it a strong escort, to throw out detachments between its line of march and the enemy; and when there are posts occupied by our troops along this line, they should keep up a vigilant system of patrols, pushing them as far out as practicable, so that the escort may receive aid and timely notice of any hostile movement. The escort, when it is deemed necessary, should be composed of all arms; but always of both infantry and cavalry, as, from the necessity of gaining timely information of the enemy's approach, patrols of cavalry must be pushed out to some distance, both in front and on the flanks.

As the convoy must be perfectly hemmed in and guarded on all points by its escort, the latter is usually divided into five principal portions with this object; an advanced-guard, which is preceded by a small detachment to scour and search the ground in front of the line of march; a rear-guard; flankers; and the main body. For the purpose of presenting a sufficient force upon those points of the convoy that will probably be assailed, the main body is subdivided into four unequal portions; one half of it will constitute a reserve; one fourth will form a guard for the center of the convoy; and the remaining fourth will be divided into two equal portions, one of which will march directly at the head of the convoy, and the other close in its rear. This subdivision of the main body is made on the supposition that the enemy will attack the convoy either at the center, or in the front or rear. If the attack is made upon either of the two last points, the divisions for their protection can be readily reinforced by the advanced- or the rear-guard. As the reserve must be in readiness to reinforce any point menaced, and to offer a vigorous resistance, its strength should be greater than either of the other divisions.

The order of march of the escort will be regulated mainly by the natural features of the ground passed over. The advanced-guard will precede the convoy about a thousand paces. The detachment by which it is preceded, and which should consist of cavalry, will push forward as far as it can with safety, taking care to scour thoroughly all the ground passed over. The flankers, which will also usually be composed of cavalry, will be divided into platoons, and be thrown out as far as circumstances will permit. Each platoon will throw out a small detachment, on its outer flank, which last will furnish vedettes to move along the outward flank of the detachment. The reserve will usually occupy some point near the center of the convoy. The rear-guard will leave about 1000 paces between it and the tail of the column. The divisions immediately at the head and tail of the train will keep close to the convoy. The center division will usually be divided into two portions, one being on each flank of the convoy; a space of eight or ten paces being left in the center of the train, for these portions to pass to either flank, as circumstances may require.

The convoy is placed under the orders of an officer, subordinate to the Commandant of the escort, who is charged with everything appertaining to its police, etc. A detachment of Pioneers, or Sappers, should precede the convoy, to repair the roads and bridges, etc. A few wagons, with all the necessary implements for the Sappers, should accompany the convoy; and it is also recommended to carry with it a few *chevaux-de-frise*, the lances of which are of iron, and connected with the bodies by hinges, to pack conveniently, in order to form a temporary obstacle against the enemy's cavalry, when the convoy parks for the night, or when threatened with an attack. When a part of the convoy consists of bat-horses or mules, they should be placed at the head of the column of wagons, as they are found to travel better in this position than when in the rear.

All the usual precautions to guard a column on the march against a surprise should be redoubled in cases of convoys. The patrols on the flanks and in front should push as far out as practicable, so that the convoy may have timely warning of an enemy's approach, in order to park, according to circumstances, before an attack can be made. With drivers accustomed to their business, half an hour at least will be required for this operation. The advanced-guard should be particularly careful to occupy by detachments any lateral roads which might offer the enemy a favorable point of attack on the convoy. These detachments will keep their posts until the convoy has passed; and they will join the rear-guard as it comes up. The officer in command of the head division, marching with the convoy, will see that his detachment moves on regularly, as the pace of the convoy will be regulated by it; and from time to time he will bring it to a halt, to allow the carriages to close up: this precaution must be carefully attended to when near an enemy.

If menaced with an attack, the divisions at the head and rear of the convoy will keep their positions and repel the enemy by their fire should he attack; the center division will move to the flank menaced, and take position to cover the two center sections of the convoy; the reserve will move towards the point threatened; the advanced- and rear-guards and flankers will close upon the convoy to be in readiness to act as circumstances may require. Before entering a defile, a detachment from the reserve should be sent forward to secure its flanks and outlet, and then send out patrols in all directions to examine the ground in front and see that all is safe. As the convoy comes up to a point designated in rear of the defile, it is parked in lines of sections. The center division of the escort will join the advanced-guard to cover the front; the rear-guard will take position to cover the rear, the flankers on the flanks, and the reserve in a central position to advance upon the point which may be attacked. When the patrols report all safe, the advanced-guard and center division pass the defile, and proceed far enough beyond it to cover the ground where the convoy will park as it reaches the other side; the reserve and flankers will cover the flanks of the convoy as it moves to its new position, and will then take post as before; the rear-guard, joined by any detachments left to secure particular points on the flanks of the defile, will follow so soon as the convoy and the rest of the troops are in position. When all the troops have passed, strong detachments are sent forward, in all directions, at least one hour before the convoy is again put in motion.

When the escort takes position at night within the park for defense, the reserve will be posted in the center, and the divisions that march with the convoy in rear of their respective sections. The advanced- and rear-guards and the flankers will take post without, and establish their outposts and sentinels in the usual way for safety. The cannon, placed at the angles of the park, will be supported by detachments of infantry and cavalry in their rear. The different divisions will throw forward skirmishers to meet the enemy if he attacks; whilst others will occupy the wagons from which they can fire. Should the enemy not be beaten off by the fire of these troops, the reserve will sally out and attack with the bayonet.

An attack upon a convoy is a comparatively easy and safe operation, and may be made with a force quite inferior to the escort, as the latter is obliged, for the security of the convoy, to keep on the defensive. It will usually be best to attempt a surprise, choosing points which are favorable to ambuscades. The manner of conducting the attack will depend upon its object, whether it be to capture the entire convoy, to cut off a part of it, or simply to delay its march. In the first case, the escort must be beaten and dispersed, whilst a detachment is sent to secure the convoy. In the second, an attack may be made on one point with the view of drawing the main body of the escort to the defense of that point, whilst a detachment attempts to cut off the part of the convoy from which the escort has been withdrawn. In the last case the convoy will be frequently menaced with an attack, to force it to halt and park for defense; the roads will be obstructed, bridges broken down, etc.

If the attack is successful, the main body of the troops should be kept together in position, to cover the captured convoy, whilst the detachment sent to secure or destroy it is performing its duty. The cavalry will endeavor to disperse the escort, and bring in all the horses that may have been cut loose from the convoy. The precaution should be taken of having spare horses in harness, in readiness to take the places of those which the escort may have cut loose, or maimed, to prevent the wagons from being carried off. For the attack of a convoy parked for defense some pieces of artillery will be necessary, and howitzers will be found particularly useful. Without the aid of this arm it will be very difficult to force a defensive park with infantry, unless the escort is very feeble, or the position chosen for the park presents covers within the effective range of musketry, from which, after keeping up a well-directed fire, a rush may be made on the park. See *Train*.

CONVOY OF PRISONERS.—The rules laid down for convoys in general apply equally to this particular class; but this is an operation presenting many difficulties, owing to the fact that they are always ready and on the alert to aid any efforts made to recapture them. Under such circumstances, when the convoy is attacked, the prisoners should be made to lie down, and warned not to arise under penalty of being shot. See *Convoy*.

COOKING.—Army cookery has become an important feature in all military systems. The sufferings in the Crimea in the winter of 1854–55 drew public attention to the subject; it was then found that cooking was little understood by the British troops, and that the soldiers seldom had meat otherwise than boiled. M. Soyer was sent out by the Government, principally to advise in reference to hospital cooking, but also to improve the system of camp-cooking, so far as military routine would allow. He devised new forms of stoves, and constructed recipes for using to the best advantage all the available provisions for a camp. The officers at Sebastopol made a highly favorable report of Soyer's *field-kitchen*, a kind of camp-stove, with a caldron holding 12½ gallons: two such stoves would easily cook for a company of 100 men; both could be carried by one mule, with sufficient dry wood for three days' fuel. Though mainly intended for boiling, the apparatus afforded facilities for many varieties of cooking. When M. Soyer returned to England he made a few improvements; and finally the apparatus presented itself as a sort of upright can, suitable for boiling, steaming, baking, roasting, stewing, and making tea or coffee: with fourteen pounds of fuel one of these would cook for fifty men; and if twenty such were placed near together, four cooks could serve for 1000 men.

A Committee which inquired into the subject of barrack economy some years ago, recommended that every large barrack should have a bakery with two ovens, where the men could learn to make and bake their own bread ; and also that the barrack-kitchens should be so furnished as to enable the men to bake their meat if so inclined, instead of being confined, as heretofore, almost wholly to boiled dinners. A School of Cookery has been formed at Aldershott, where men are trained to act as Sergeant-cooks, of whom there is now one to each regiment. His duty is to superintend and direct the operations of the soldiers detailed from the several companies to act as cooks.

At various times in 1859 and 1860 certain highly ingenious forms of apparatus were tried, to test the possibility of cooking for troops while *the kitchen itself is on the march*. One of these inventions consists of a compact set of stoves and caldrons, fitted into a wagon, and has been found on trial to answer the purpose perfectly. For a detailed account of field-cookery and campaign recipes, see FARROW'S MOUNTAIN SCOUTING, Chapter XII. (New York, 1883).

COOLING.—The operation following *casting* in the fabrication of cast guns. The water for cooling the gun is taken from a hydrant where the supply is constant and uniform, the connection being made by rubber hose. It is conducted into the core by means of a metallic tube which passes through a water-tight joint in the center of the cap and extends to within a few inches of the bottom of the barrel. The water consequently passes into the core at the bottom and ascends until it reaches the escape-pipe and is discharged. The flow of the water commences as soon as the furnaces are tapped, and is regulated to produce, half an hour after the casting, a certain change of temperature, about 25°, between entering and leaving the core. When this is effected the rate of flow remains constant until the core is removed. As soon as possible after the casting the fire in the pit is kindled and kept up until the withdrawal of the core-barrel; it is allowed to die out gradually. Meanwhile the mouth of the pit is kept closely covered. When the change of temperature of the outflowing water has become constant or nearly so, the core-barrel is withdrawn. To effect this, it is sometimes necessary to largely increase the flow of water for a short time, in order to contract the barrel enough to loosen it from the casting. As soon as this is effected the flow is stopped. The rope with which the barrel is wrapped takes fire from the heat of the casting and is consumed, leaving the barrel detached from the composition surrounding, and allowing its withdrawal without difficulty. As soon as the core-barrel is withdrawn the water is turned into the bore, being conveyed by the conducting pipe to the bottom, and escaping by means of a tube cast into the gun-head, entering the bore a few inches from the upper end of the casting. The rate of flow of the water through the bore is so regulated as to produce a change of bout 100° between entering and leaving at half an hour after the removal of the barrel. It is then allowed to remain constant until the gun becomes cool. The time occupied in cooling by this process varies from four to six days, according to the size of the gun; for a 20-inch gun a longer time may be required. In case the condition of the metal in the furnace before casting should indicate that a slower rate of cooling is desirable, the process of cooling by air is resorted to after the withdrawal of the core-barrel. The current of air is furnished by a rotary blower driven by steam or water power, and is conducted into the gun by a sheet-iron pipe which extends to within a short distance of the bottom of the bore. Cooling by this process usually requires two or three days more than by the water process. See *Cooling of Castings* and *Rodman Gun*.

COOLING OF CASTINGS.—The enormous time required by a large casting for cooling is not generally known. A solid casting sufficiently large for a 15-inch gun weighs about 35 tons; it is red-hot three days after having been cast, and only becomes cold enough to handle after a fortnight. The cooling of a casting must be uniform, so far as uniformity is possible. This is impossible strictly in any casting; the approach to it is most difficult in heavy solid castings, and hence the great advantage of the practice of hollow-casting upon a suitably made core, admitting of internal cooling by artificial means.

The contraction of cast-iron in becoming solid introduces strains into the mass by consolidation of one portion of the casting before another. When a large gun is cast solid and the metal cools in the ordinary way, the external portions solidify long before the interior has ceased to be liquid, and the process of solidification is propagated, as it were, in parallel layers from the outside to the center of the mass. When the first layer or thickness of solid crust has formed in the exterior, it forms a complete arch all round, so that the contraction between fluidity and solidification of each subsequent layer is accommodated by portions of matter withdrawn radially from the interior toward the still cooling exterior; that is to say, from a smaller toward a larger circumference.

The final effect of this, propagated to the center of the mass, is twofold. First. To produce a violent state of internal tension in the particles of the metal in radial lines from the axis of the gun inward as a cylinder, tending to tear away the external portions of the mass from the internal nucleus. Second. To produce about the center or along the axis a line of weakness, and one in which the texture of the metal is soft, porous, and of extremely low specific gravity. The effect of this unequal contraction may be so great as to crack the interior metal of cast-iron cannon, even before it has been subjected to the force of gunpowder ; and large masses of iron which have been cooled very rapidly by casting them in iron molds have been known to split open longitudinally, from no other cause than the enormous strains to which they are thus subjected.

The great improvement in the fabrication of cast-iron guns is Captain Rodman's process of cooling them as far as possible from the interior, and for this purpose casting them hollow. The design is to remedy the various defects of the old process; principally to obviate the tendency of solid castings to burst by their own initial strains, by reversing the process of cooling and shrinking described above. Since there would then be no force opposed to the contraction of the inner layers of metal, except the trifling cohesion of the liquid or pasty mass that they shrink away from, they would not be left in tension, and therefore they could not exert any power to pull the exterior layers into compression.

The method employed is to carry off the internal heat by passing a stream of water through a hollow core, inserted in the center of the mold-cavity before casting, and to surround the flask with a mass of burning coals to prevent too rapid radiation from the exterior. Extensive trials have been made to test the merits of this plan, and the results show that cast-iron cannon made by it are not only stronger, but are less liable to enlargement of the bore from continual firing, the surface of the bore being the hardest and densest part of the casting, and best calculated to resist pressure and abrasion. See *Cast-iron Guns*, *Ordnance*, and *Rodman Gun*.

CO-ORDINATES.—What is termed the method of co-ordinates is an invention of Descartes, whereby algebra and the calculus may be employed in geometrical investigations. The method is sometimes called algebraical geometry—sometimes, and more properly, analytical geometry; and it is commonly treated under the head of "geometry of two dimensions" or of "geometry of three dimensions," according as it is applied to investigate the properties of figures all in one plane, or of curved surfaces. The method is capable of a popular explanation. Co-ordinates are lines so measured off from a fixed point, called the origin of co-ordinates, and along fixed lines passing through it, called the axis of co-ordinates, as to determine by their quantities the position of any other point relative to the origin. The first step is to find how to determine the position of a point in a plane. Take any fixed point in it for the origin of co-ordinates, and through it draw two fixed lines—the co-ordinate axes—at right angles to one another. Then, if the perpendicular distance of the point from each of these axes be given, its position will be determined. Referring to Fig. 1, if P be the point, and O be taken for the origin of co-ordinates, OX, OY for

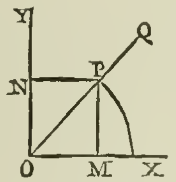


FIG. 1.

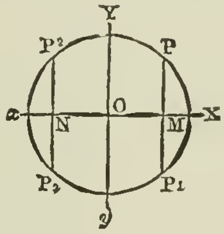


FIG. 2.

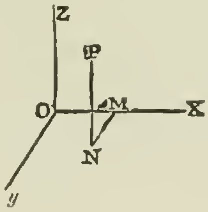


FIG. 3.

the axes, then if we know NP or OM, the perpendicular distance of P from OY, and measure off from O, OM on the axis OX, and through M raise a line perpendicular to OX, P must lie in this line, for it contains all the points in the plane which are at the perpendicular distance OM from the axis OY. Similarly, if ON or PM, the perpendicular distance of P from the axis OX, be known, and we measure that distance off from O along OY, and through N draw a perpendicular to OY, the point must be in that perpendicular. It is therefore at the intersection of the perpendiculars through M and N respectively. When, as in the figure, the fixed lines are at right angles to one another, the co-ordinates OM, ON are called the rectangular co-ordinates of the point. Let us now see what use can be made of this mode of determining the position of the point, for the discovery of the properties of lines and surfaces. As the values of the co-ordinates change for the different points in the plane, they are denoted by the variables x and y. Now, if we suppose the point P to begin to move according to a determinate law, and the co-ordinates to change their magnitudes so as always to be its co-ordinates, knowing the law of P's motion, we are able to express in algebraical phraseology the law of the corresponding changes in its co-ordinates. For instance, if P moves so as to be always at the same distance from O, OP is constant, and the square on OP is equal to the sum of the squares on OM and PM. Putting this into algebraical language, we have the equation $x^2 + y^2 = R^2$, or $y = \pm \sqrt{R^2 - x^2}$, where $R = OP$. This is called the equation of the circle referred to its center as origin, and to rectangular co-ordinates; and it expresses the law according to which the changes of the co-ordinates must take place: and from this equation, combined with that of a straight line, etc., every property of the circle may be determined. If P move so that the sum of the distances from two fixed points shall be always the same, and we express the relation between x and y in that case, we should have the equation of an ellipse. This suffices to show in a general way the nature of the method. Equations between x and y are called the equations of the lines, whether straight or curved, traced out by the point P; and by means of them, though they but express relations between *quantities*, the *qualities* of the lines to which they refer may, by artifices explained in every treatise on the subject, be detected. Nay, by assuming equations between x and y, and examining the lines which points represented by them would trace, many singular curves have been discovered. There are a variety of conditions to be attended to in the interpretation of such equations, depending on the assumptions set out with, in choosing the origin and axis. The axis of x or OX being taken to the right of the origin, and the axis of y or OY being perpendicular to it and above it, x and y are counted positive when they are measured along their axes to the right of and above the origin respectively, and negative when they are measured to the left and downwards respectively. Suppose $x = OM = ON$, and $y = MP = MP_1 = NP_3 = NP_2$: the co-ordinates of the points P, P_1, P_2, P_3 would be $(+x, +y)$, $(+x, -y)$, $(-x, +y)$, $(-x, -y)$ respectively. These points being equidistant from O, we may suppose a circle to pass through them. Recurring now to the equation of the circle, $y = \pm \sqrt{R^2 - x^2}$, the meaning will be seen of the two values $+$ and $-$ of y given by the quadratic. Often the axes of co-ordinates selected for convenience are oblique, i.e., inclined at some other angle than a right angle. An equation between co-ordinates referred to one set of axes may always be transformed to co-ordinates referred to another, by the process known as the transformation of co-ordinates. A similar transformation of equations by the same process may be made where it is desired to refer the line to a new origin.

What has been said above refers to the co-ordinates of a point in a plane, or to what is called geometry of two dimensions. But the rationale is the same with that of connecting in equations the co-ordinates of points in space—the subjects of geometry of three dimensions. The position of a point in space requires three co-ordinates to determine it, and these are usually denoted by the symbols x, y, z. An origin being taken, and three axes, OX, OY, OZ, mutually at right angles to one another, the point is referred to the three planes through these axes. z, or PN, is its height above the plane through YOX; y, or NM, is its distance perpendicularly from the plane XOZ; and x, or OM, is its perpendicular distance from the plane ZOY. It is clear that these three determine the position of the point. In three dimensions, as in two, the problem may be stated to be: Given the law of the motion of P, to express the law regulating the variations of its co-ordinates as it moves. The algebraic expression of the latter law is, the equation of the surface traced by the point in moving over all the space it can traverse consistently with the law of its motion. The method of co-ordinates, besides its use in geometry, is of great value for resolving forces in gunnery, and also for finding the resultant of a great many of them. See *Trajectory*.

COPING.—The merlons or rising parts of battlements are sometimes called cops, but the term *coping* is usually applied to the covering course of a wall, which is made either sloping or round, so as to throw off water. Where the coping is of hewn stone, it is frequently ornamented with a circular molding running along the top, and sometimes the angle at the top is simply taken off to prevent it being chipped.

COPPER.—One of the most anciently-known metals, whose name is derived from the Island of Cyprus, where it was first obtained by the Greeks. In the earlier times copper does not appear to have been employed by itself, but always in admixture with other metals, principally tin, forming what is now called bronze. There is every reason to believe that, next to the large quantities of tin which they obtained, one of the great inducements which the Phenicians had in making searches for metals in Great Britain was the copper which they procured in their workings in Cornwall.

Copper is sometimes met with in nature in a state of purity, but generally it is associated with oxygen, water, and carbonic acid, forming the native carbonate of copper or *malachite* ($CuO,HO + CuO,CO_2$), or with iron and sulphur, forming the native sulphurets of copper and iron or copper *pyrites* (Cu_2S,Fe_2S_3). In smaller quantity copper occurs as the oxide (CuO) and sulphate ($CuOSO_3$), and in all cases the ore is obtained from fissures or veins in other rocks. The principal yield of copper-ore in Great Britain is from the mines in Cornwall, but large supplies are also obtained from Australia, and from Cuba and Chili in South America. In North America, in the neighborhood of Lake Superior, copper-ore occurs abundantly, and a vein of metallic copper is there found which in some places is about two feet in thickness.

In the extraction of copper from its ores the metallurgic processes followed are very tedious and complicated, which mainly arises from the difficulty of separating the iron and sulphur from the copper. The general principle which regulates the working-up of the ore is to burn away the sulphur (S) as sulphurous acid (SO_2), and to carry off the iron by means of fluxes in the form of scoriæ or slag. Metallurgists enumerate ten distinct steps in the production of commercially pure copper.

Copper has the equivalent 31.7—new system, 63.4. It is the only red metal, has the specific gravity 8.78 when cast, and 8.96 when rolled or hammered; fuses at 1996° F., and at a white heat passes off in vapor, and burns with a green flame. It is very malleable, and can thus be beaten out into thin leaves; is very ductile, so as to admit of being drawn out into thin wires; and its tenacity is only inferior to that of iron. It is a powerful conductor of electricity, and hence is employed in the construction of lightning-conductors and in telegraph-wires for underground or submarine communication. Copper is also employed largely in the sheathing of wooden vessels and in the arsenal.

Copper forms many compounds. There are two oxides, the black oxide (CuO) and the red oxide (Cu_2O). The latter is employed in coloring glass of a ruby-red tint. The *green rust* which forms on the surface of a copper-sheeted ship, and on copper coins and vessels which lie in moist places for some time, is a carbonate of copper, and is due to the carbonic acid and oxygen of the air acting upon the copper in the presence of moisture. It is very poisonous, and hence any barnacles which may attach themselves to the copper sheathing are poisoned. The carbonate of copper, under the name of *blue verditer*, is largely prepared and sold as a pigment. The subchloride of copper, moistened and exposed to the air, yields the pigment known as *Brunswick green*. There are several compounds obtained by allowing acetic acid to act upon oxide of copper which are commercially called *blue* and *green verdigris*. The sulphate of copper, or *blue vitriol* ($CuO,SO_3 + 5HO$), is prepared by dissolving the black oxide in sulphuric acid, and allowing the salt to crystallize out. The crystals are large and present a fine blue color. It is soluble in water, and is extensively used by the dyer for the production of several blue and green colors. The solution of blue vitriol is also employed in the preservation of timber from dry-rot, and it forms a constituent of some writing-inks. See *Bronze* and *Cannon-metals*.

COPPER SCISSEL.—The clippings of copper left after the formation of percussion-caps, friction-tubes, coinage, etc.

COPTIC LEGION.—In 1799 the French troops in Egypt, not receiving any reinforcements, grew weaker every day through loss in combat and disease, when General Kleber, who commanded after the departure of Napoleon, organized a Corps of Copts, or native Christians, about 600 strong, which was known as the Coptic Legion. They were armed the same as the French soldiers.

COPYING.—A term applied in photography to the reproduction of paintings, engravings, manuscripts, maps, etc. The kinds of camera and lens most suitable for the purpose will be found described under their respective heads; the quality and condition of chemicals necessary are based upon the facts, that long exposure is almost invariably required, and that, in the majority of cases, it is desired to copy black marks upon a white ground, as in a sheet of music, for example. Where it is obvious that nothing that can be called a middle tint is required, but simply pure black and white, recourse should be had to organic matter in the bath; a little acetate of soda and an extra amount of acetic acid may be also added, and an old collodion containing free iodine employed. It is important that the work or surface to be copied should be placed in a strong light, and exactly at right angles to the axis of the lens, which should be furnished with a *small* stop. These three conditions, it will be seen, are such as are calculated to insure density in the blacks of the negative, freedom from distortion, and sharpness at the edges of the picture. The copying of oil-paintings seems to the amateur, at first sight, to present almost insuperable difficulties, on account of the reflected light from the varnish passing through the lens, and producing black patches on the negative. This may, however, be completely avoided by the employment of a lens of long focus, which admits of the oblique pencils of light passing off without entering the camera. Attention to the laws of the reflection of light will suggest to the reader the importance also of avoiding a bright light immediately behind the camera, as the rays of light would then fall on the varnished surface, nearly at right angles, and be reflected into the camera. The oil-painting, therefore, though placed in strong sunshine, for the purpose of giving vigor to the more obscure parts, should be so arranged as to allow the light to fall on it at an angle of about 35° or 40°.

COPYING MACHINES.—The various contrivances for procuring duplicates of writings without the labor of transcribing them may be reduced to two classes. In the one the writing is first made and then copied; in the other the copy and the original are produced at the same time. The essence of the first method is this: In writing the original, an ink is used that is made for the purpose, or common ink thickened by the addition of a little sugar. When the writing is dry, a damped sheet of thin unsized paper is laid upon it, and over this a piece of oiled paper. The whole is then subjected to pressure, and the damped paper is found to have taken off an impression of the writing. It is of course the reverse of the original, but the nature of the paper allows it to be read right on the other side. The machines for communicating the pressure are of various kinds. Some pass the sheets between rollers like the copper plate press; others act on the principle of the common printing-press. A simple plan is to wrap the sheets round a wooden roller of about an inch diameter, lay this upon a table, and roll it under a flat board, pressing all the while. Another very common method of copying is by means of prepared blackened paper laid between two sheets of thin writing-paper. The writing is traced firmly on the upper sheet with a steel or agate point or common black-lead pencil, and the lines are found transferred in black from the blackened sheet to the paper adjacent. By having several of these blackened leaves, a number of copies may be produced at once. The blackened paper is prepared by saturating it with a mixture of lard and lamp-black, and cleaning it so far that it will not soil paper unless pressed against it.

CORBIE.—A word obsolete in English except as a heraldic term for a raven. See *Heraldry*.

CORDAGE.—*A rope* is composed of threads of hemp or other fibrous material. These threads are called *yarns*. A number of these yarns twisted together form a *strand*, and three or more strands twisted together form a rope. The ropes in ordinary use are composed of three strands laid *right-handed*, or, as it is called, *with the sun*. Occasionally a large rope will be found laid up in four strands, also *with the sun*. This is generally used for stationary rigging, such as shrouds, guys, heavy gun-slings, etc., and is sometimes called *shroud-laid*. Small halyards are sometimes laid with four strands and a core; this kind of rope runs more smoothly and wears longer. *Cable-laid rope* is composed of nine strands, and is made by first laying up three ropes of three strands each, with the sun, and then laying the three ropes up together into one, against the sun. Right-hand rope must be coiled *with* the sun, and cable-laid rope *against* the sun. *The size* of rope is always given in inches and fractions, and is measured on the *circumference*, for the reason that it is seldom possible to get a squarely-cut end in order to measure the diameter. In making requisitions for rope, it should be clearly indicated that this measure is the one considered. *Spun-yarn* is made by twisting together very loosely two or more well-tarred yarns, and is designated by the number of its yarns; as, two-yarn, three-yarn, etc. It is used for serving, seizings, stops, etc., and is very pliable. *Marline* is also made of tarred yarns, but is tightly twisted, and is much harder and smoother than spun yarn. It is not fit for serving when the rope served is to be bent up, as it is not pliable enough to cover the rope in such cases. *The bight* of a rope is any part not an end. A *bight* is formed by bending or doubling the rope so as to form a loop. This distinction should be particularly noted, and the two terms should not be confounded. The interstices between the strands of a rope are called the *jaw*, and rope is called long or short jawed as it is loosely or tightly laid up together. Those ropes which are stationary are called *standing* rigging; as, guys for a gin, gun-slings, etc. Those which run through blocks or pulleys, such as gin-falls, trace-ropes, etc., are *running* rigging.

Worming a rope is filling up the divisions between the strands by passing spun-yarn along them, to render the surface smooth for parceling and serving. *Parceling* a rope is wrapping narrow strips of canvas about it, well tarred, in order to secure it from being injured by rain-water lodging between the parts of the service when worn. The parceling is put on *with* the lay of the rope. Parceling is also used to prevent chafing or cutting of a rope when a strain is brought against a rough surface or sharp edge. For this purpose old rope or canvas wound around is sufficient. *Serving* is the laying on of spun-yarn or other small stuff in turns round the rope, close together, and hove taut by the use of a serving-board for small rope and serving-mallet for large rope. Small ropes are sometimes served without being wormed, as the crevices between the strands are not large enough to make the surface very uneven; but a large rope is always wormed and parceled before being served. The service is put on *against* the lay of the rope. *Whipping* is securing the end of a rope with twine to prevent it from fraying out. For temporary use it may be done by winding twine about the end of the rope and securing the end of the twine by passing it under two or more turns of the twine and pulling it tight. It is better, however, to secure the ends by sewing them through the rope, so that each stitch may lie in the division between two strands. This is called a *sewed* whipping.

Splicing is putting the ends of ropes together by opening the strands and placing them into one another, or by putting the strands of the ends of a rope between those of the bight. (Fig. 1.)

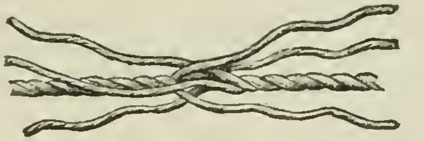


Fig. 1.

A Short Splice.—Unlay the strands for a convenient length; then take an end in each hand, place them one within the other, and draw them close. Hold the end of one rope and the three strands which come from the opposite rope fast in the left hand, or if the rope be large, stop them down to it with a rope-yarn. Take the middle strand, which is free, pass it *over* the strand which is first next to it, and then through *under* the second and out between the second and third from it, then haul it taut. Pass each of the six strands in the same manner; first those of one end and then those of the other. The same operation may be repeated with each strand, passing each *over* the third strand from it, *under* the fourth, and through; or, as is more usual, after the ends have been stuck once, untwist each strand, divide the yarns, pass one half as above described, and cut off the other half. This tapers the splice.

A Long Splice.—Unlay the ends of two ropes to a distance three or four times greater than for a short splice, and place them within one another as for a short splice. Unlay one strand for a considerable distance and fill up the interval which it leaves with the opposite strand from the other rope. Twist the ends of these two together, then do the same with two more strands. The two remaining strands are twisted together in the place where they were first crossed. Open the two last-named strands, divide in two, take an overhand knot with the opposite halves, and lead the ends over the next strand and through the second as the whole strands were passed for the short splice. Cut off the other two halves. Do the same with the others that are placed together,

Fig. 2.

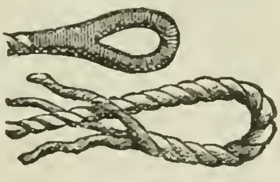


Fig. 3.

dividing, knotting, and passing them in the same manner. (Fig. 2.) *Before cutting off any of the half strands the rope should be got well upon a stretch.* Sometimes the whole strands are knotted, then divided, and the half strands passed as above described. This splice does not increase the diameter of the rope, and is used for splicing a fall or other rope that runs through blocks or pulleys.

An Eye-splice.—Unlay the end of a rope for a short distance and lay the three strands upon the standing part, so as to form an eye. Put the first end through the strand next to it. Put the second end over that strand and through the second, and put the remaining end through the third strand on the other side of the rope. (Fig. 3.) Taper them, as in the short splice, by dividing the strands and sticking them again. This splice is used to form a permanent loop in the end of a rope.

A Grommet.—Take a strand just unlaid from a rope, with all its turns in it, and form a ring of the size you wish by putting the end over the standing part. Then take the long end and carry it twice round the ring in the crevices, following the lay until the ring is complete; then take an overhand knot with the two ends, divide the yarns, and stick them as in the long splice. Used for a trunnion-loop for rolling or slewing a gun. See *Blocks*, *Mechanical Maneuvers*, and *Rope*.

CORDON.—1. In military operations, a line of sentries inclosing or guarding any particular space of ground, to prevent the passage of persons other than those belonging to the army. The sentries are placed within sight of each other. If intended to guard against contagious diseases, it is called a *Cordon Sanitaire*.

2. The coping of the escarp or inner wall of the ditch, sometimes called the magistral line, as from it the works in permanent fortification are traced. It is usually rounded in front, and projects about one foot over the masonry: while it protects the top of the revetment from being saturated with water, it also offers, from projection, an obstacle to an enemy in escalading the wall.

CORDUROY-ROAD.—A roadway formed of logs laid side by side across it, as in marshy places; so called from its rough or ribbed surface, resembling corduroy.

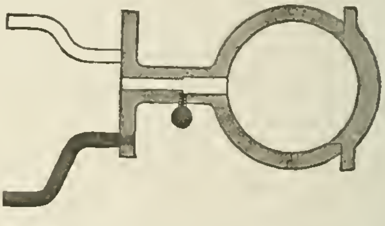
CORE-BARREL.—The core-barrel, as represented in the engraving, consists of a water-tight iron tube, AD, about fifteen feet long and three fourths of an inch thick, its exterior diameter at the head being twelve inches, and tapering one fourth of an inch, at the lower extremity, to facilitate its withdrawal after the cast. It is rounded at its lower end, D, and fluted throughout the cylindrical part, to allow the escape of gas generated by the burning of the composition with which it is covered. To prepare the core for casting, journals are first fitted, at either extremity of the barrel; it is then placed in a horizontal position upon an iron truck, being supported by the journals, which rest in bearings. While so supported it is easily turned by means of a crank attached to one of the journals, and is first wrapped or served with white-hemp stuff (18-thread), covering that portion of the barrel which comes in contact with the molten iron. Over this a coating of molding-composition is applied quite wet, which is wrapped with twine, to insure its adhering. When about half dry the outer or last layer of composition is applied, which, being made quite sticky, adheres readily. Great care is taken to have the surface of the core perfectly smooth, and the composition of uniform thickness. The diameter of the core-barrel for a 15-inch gun, when complete, is 13.75 inches at the top, and slightly tapered at the bottom. When ready, the truck supporting the core-barrel is rolled into the drying-oven, and when perfectly dry removed; the usual time required being eighteen hours. The composition then receives a coating of coke-wash, when it is again placed in the oven, where it remains until thoroughly dry. Upon its final removal the journals at either extremity are removed, being replaced by the regular cap on top, and a tight-fitting screw-plug at the bottom, which is covered with molding-composition, and dried by a fire built under it.

The gauge for centering the core consists of a long wooden rod, on the end of which a piece of board is fixed at right angles, and on this board a light is placed. The length of this projecting board, previously determined, is the distance the core should be from the mold when in the center. Having adjusted the core in the mold by means of the screws fitted in the legs of the spider, it is secured firmly by clamps, made to fit over the top of the frame and under the flange of the flask.

The core-barrel is withdrawn about eighteen hours after the casting, as soon as the metal becomes sufficiently cool to permit of its removal. The withdrawal causes no delay or trouble, as the rope with which it is wrapped is consumed, and therefore leaves the barrel detached from the composition surrounding it, the latter adhering to the bore of the gun. See *Molding*.

CORE-BOX.—The core-box, employed in the fabrication of hollow projectiles and shown in the drawing, consists of two hemispherical cups. The lower one is made in two sections, which are so constructed as, when united, to receive and hold the spindle in place, and also to form a base for the core-box to rest upon while being filled. The core is formed by pouring the composition into the opening at the top of the upper cup and ramming it down until the interior space is filled. The surface at the opening is then rounded off with a former, and the core-box is removed. The core is then thoroughly dried in an oven and afterward painted with coke-wash.

The requisite compression being given by screws, the core is by means of a gauge placed exactly in the



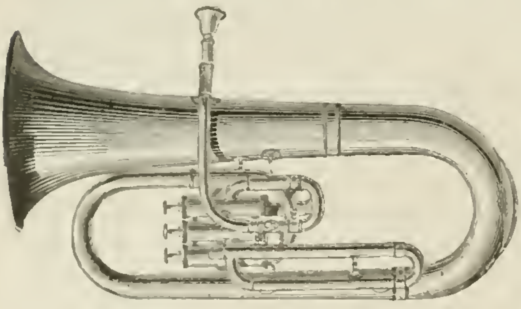
center of the mold and supported in that position by the stem which forms the fuse-hole. The stem is perforated with small holes to allow of the escape of steam and gas generated by the heat of the melted metal; that part of it which comes in contact with the melted iron and forms the fuse-hole is coated with sand. In pouring the melted iron into the mold with the ladle care should be taken to prevent scoria and dirt from entering with it, and for this purpose the surface should be skimmed with a wooden stick. After the iron has become sufficiently hardened, the flasks are opened and the sand knocked from the casting. Then the core is broken up and removed, and the interior surface cleaned by a scraper. The greatest care is to be taken to remove every particle of sand or fragment of iron from the interior. The sinking-head or projecting portion at the gate, and around the base where the two halves join, is taken off with a file or chisel if necessary. A number of the balls are now placed in a large revolving iron cylinder, which by friction polishes and makes the surface more uniform. See *Fabrication of Projectiles*.

CORED SHOT.—An elongated projectile having a cavity in the body of it. This cavity is for the purpose of throwing the center of gravity towards the front end of the projectile, thus insuring greater steadiness of flight. The hollow projectiles are either shells or case-shot, both of which, in their construction and use, are similar to those described for smooth-bore guns. Rifle-projectiles have a length of two to three times their diameter, depending upon the pattern, and whether solid or hollow, the latter being generally the longer. See *Projectiles*.

CORMONTAIGNE SYSTEM OF FORTIFICATION.—Cormontaigne, the immediate successor of Vauban, holds a place only second to this master of the art in the estimation of the engineers of the French school. In planning the front which has received his name, Cormontaigne seems to have applied himself rather to remedy the defects noticeable in the methods of Vauban than to produce any radical change in the combinations which had thus far received the sanction of engineers generally. Observing that from the great height given by Vauban to his scarp-walls they might be easily breached from a distance, Cormontaigne suppressed the small wall supporting the parapet and diminished the height of the scarp-wall, placing the top of it on a level with the crest of the glacis. He adopted as a principle *that all masonry should be masked from the fire of the enemy's batteries at a distance*, and to obtain this point he has so arranged the height of his principal scarps, and the command given to the glacis crest in front of them, that the top of the scarp shall not lie above the level of the crest, thus masking from view the entire scarp, by the earth forming the glacis, from all positions in advance of the glacis crest. Cormontaigne was the first to develop clearly the influence of large demi-lunes on the progress of the attack, by their forming deep re-enterings between them in front of the bastion salients. Also the increased strength gained by fortifying on a right line, or on polygons with a great number of sides. In both of these cases the fronts assailed cannot be enveloped by the assailant's works, and the demi-lunes from their salient position intercept the prolongations of the bastion-faces, thus masking them from the positions from which alone an enfilading fire could be brought upon them. The modifications of Vauban's trace are different in the various works of Cormontaigne; but the following he indicates in his memoirs as the one preferred by him. The exterior side is 360 yards; the perpendicular, $\frac{1}{6}$; the faces of the bastions, $\frac{1}{3}$ of the exterior side; the flanks are 40 yards, and are so placed that the curtain shall be 120 yards. This combination makes the lines of defense somewhat less, and the bastions larger, than in Vauban's method. The dimensions of the enceinte-ditch are so regulated by Cormontaigne as to furnish earth sufficient for the embankments. It is 28 yards wide at the salient, and from 2 to 4 yards wider opposite the tenaille; this admits the entire fire of the flanks to sweep the ditch. The tenaille is made with a curtain and wings; a ditch 10 yards wide being left between it, the curtain, and the flanks. Cormontaigne placed little value on small demi-lunes, as they form but slight and therefore weak re-enterings before the bastions, and consequently retard but little the enemy's attack upon them; besides this, a small demi-lune covers but very imperfectly the shoulder-angles of the bastions. To remedy these defects, his demi-lune is so laid out that the prolongations of the magistrals of its faces will intersect the bastion-faces at 30 yards from the shoulder-angles; the lengths of its faces being 120 yards. To circumscribe as much as practicable the space in the demi lune which the enemy, after he gains it, requires for his works, the extremity of the demi-lune terre-plein, which is also the top of the counterscarp of the redoubt, is drawn at 20 yards from the magistral of the face; the ditch of the redoubt is 10 yards wide, and the magistral of its face is parallel with the counterscarp. By this arrangement the ditch is well flanked by the face of the bastion near the shoulder-angle. The general width of the covered-way is 10 yards. Cormontaigne enlarged considerably the re-entering place-of-arms, to which he added a redoubt with a revetted scarp and counterscarp. The addition of this work is a great improvement upon the covered-way of Vauban, who indicates in his works small redoubts of earth, or tambours of wood, for the same purpose. Cormontaigne's redoubt increases the strength of the covered-way; the troops assembled in the covered-way for sorties are secure under its fires; it sees in reverse, and protects any breach made in the face of the demi-lune; finally, it serves, in connection with the extremity of the demi-lune, to cover the opening left between the flanks of the bastion and the wings of the tenaille, through which, if a breach was made in the curtain, the interior retrenchments, resting upon either the flanks or faces of the bastion, could be turned. Traverses are placed along the covered-way, to close the places-of-arms, defend the covered-way, and intercept projectiles fired in ricochet. The crest of the glacis is broken into a cremaillère line, to allow room for the defiles of the traverses. The short branches of the cremaillère throw a fire on the salients of the covered-way; the positions of the long branches are so taken that the defiles may be seen and swept by the fire of the works in their rear. Cormontaigne, after a series of trials, whose object was to give the ditches such dimensions that they should furnish the earth required for the embankments, regulated the command of the different works as follows: The lowest work, which is the demi-lune covered-way, he lays down as a rule, shall command the exterior ground by not less than 7½ feet; and the works most advanced shall be commanded by those in the rear. It was found that, for the purpose of equalizing the excavations and embankments of the front, the crest of the demi-lune covered-way should have a command of 10½ feet above the natural ground. The crest of the bastion covered-way, and of the re-entering place-of-arms, commands the crest of the demi-lune covered-way by 2 feet. The magistral of the enceinte is horizontal, its elevation being the same as the mean elevation of the crest of the bastion covered-way. The scarp-wall is 30 feet high. This dimension has since been generally adopted by engineers. The relief of the tenaille is determined as in Vauban's method, so as not to mask the fire of the flanks upon the ditch opposite the extremity of the demi-lune; as it is here that a breach may be made in the bastion-face, through the ditch of the demi-lune. The demi-lune is commanded by the enceinte 3 feet, and by its own redoubt 1½ feet. The demi-lune, therefore, commands its covered-way 7 feet. The redoubt of the re-entering place-of-arms commands the crest of the glacis only 4½ feet; its interior crest is so placed as not to mask the fire of the bastion faces on the glacis in advance of it. The interior crests of all the works are 7½ feet above their terre-pleins, except that of the tenaille, which is 6½ feet; and of the redoubt of the re-entering place-of-arms, which is 9 feet. The interior crests of the faces of all the works exposed to enfilading fires are one foot higher at the salients than at the extremities. The profile of the parapet of the principal outworks is the same as that of the enceinte. The communications are generally of the same nature, and placed about in the same positions, as in Vauban's method. The planes of the glacis are so determined that they may be swept by the fire of the works in the rear; their inclination is usually about twenty-four base to one perpendicular. When a greater command of the site than that afforded by the enceinte is requisite on any front, Cormontaigne places a cavalier within the bastion. To this work he gives the same form as that of the bastion; placing the faces and flanks of the two parallel to each other. The faces of the cavalier are alone revetted, as well as the counterscarp of their ditch, which is cut within the bastion. This ditch is broken off at the shoulder-angles of the cavalier, and directed upon the faces of the bastion; these portions also having a revetted scarp and counterscarp. A parapet is thrown up behind the scarp, and between the flank of the cavalier and the bastion faces; thus isolating the anterior portion of the bastion, and furnishing an interior retrenchment which, when the shoulders and flanks of the bastions are masked from the assailant's view, can only be carried by a breach made either in the cavalier-face, or in the portions resting on the cavalier and bastion faces. From the preceding it appears that the most important modifications made by Cormontaigne in Vauban's first method consist—1. In the means taken to cover the *masonry* from distant batteries. 2. In more capacious bastions susceptible of receiving efficient permanent interior retrenchments. 3. In an enlarged demi-lune, which places the bastions in strong re-enterings, covers the shoulder-angles, and admits of a redoubt in its interior, which work strengthens the demi-lune, and sees in reverse the breach made in the bastion-face. 4. In an enlarged re-entering place-of-arms, containing a redoubt which strengthens the entire covered-way, and covers the movement of the troops in sorties. These modifications, although of great value, and constituting an important step in the art, still leave much to be desired; and engineers since Cormontaigne's time have sought to remedy the defects of his method, of which the following are the principal: 1. The enceinte has rather too slight a command, and is without any bomb-proof shelters. 2. The inclination of the superior slope of its parapet, which is ⅙, is too small to have the ditches well flanked. 3. A breach can be made in the bastion-face through the ditch of the demi-lune. 4. There are dead spaces in the ditch of the demi-lune, near the extremities of its faces. 5. The redoubt of the re entering place-of-arms is not tenable after the demi-lune is taken. 6. The traverses of the covered-way do not afford the requisite protection to that work. 7. Finally, the communications are mostly inconvenient, and not well covered from the assailant's fire. See *Fortification* and *System of Fortification*.

CORNET.—1. A metallic wind-instrument resembling a trumpet, and used in bands. The *cornu* of the Romans, like the instruments mentioned in Leviticus (xxv. 9), was curved and formed from a horn. It was afterwards of metal, probably copper. Its invention is credited by Athenæus to the Etruscans. It differed from the *tibia* in being larger, and from the *tuba* in being curved. It had no keys or stopples.

The cornet-à piston, represented in the drawing, is a



modern wind-instrument of the trumpet kind, is generally made of brass, has two or three valves, and in brass bands takes the soprano and contralto parts. It was first introduced in France as an orchestral instrument. Its tones are less powerful, but far more easily manageable, than those of the trumpet. See *Band*.

2. In the British service, the lowest grade of commissioned officer in the cavalry, equivalent to *Ensign* in the infantry, his duty being to bear the standard. With the Lieutenant, he assisted the Captain in the daily duties connected with the troop to which he belonged. There were as many Cornets in a cavalry regiment as there were troops. A Cornet's commission used, in the days of "purchase," to cost £450; but much larger sums were habitually paid, varying according to the celebrity, or rather the fashionable character, of the Corps. The pay was 8*s*. per day, with 1*s*. or 1*s*. 6*d*. extra for field-allowance. The half-pay varied from 2*s*. 6*d*. to 3*s*. 6*d*. The pay being utterly inconsistent with the price paid for the commission, none but wealthy men could enter the cavalry. In 1871 the rank was abolished, Sub-Lieutenants (who are merely probationary Lieutenants) being substituted.

CORNETTE-BLANCHE.—An ornament which in ancient times served to distinguish French officers who were high in command. It was worn by them on the tops of their helmets. It likewise meant a Royal Standard, and was substituted in the room of the Royal Pennon. The Cornette-blanche was only unfurled when the King joined the army; and the persons who served under it were Princes, Noblemen, Marshals of France, and old Captains, whose orders came direct from the King.

CORNING.—That process in the manufacture of gunpowder which takes place after the cake is removed from the hydraulic press—having been previously broken down—to the granulating-house, when it is passed through rollers and sieves, until the different-sized grains are formed. Corning is another term for granulating. See *Gunpowder*.

CORONA.—An upper saddle-blanket used in packing. Next to the skin of the animal is placed a piece of clean cloth, or an ordinary woolen blanket neatly folded; over this is placed the *corona*. It is made of woolen cloth, with worked ornamental borders, and consists of two or three folds stitched together. The number or name of the animal to which it belongs is generally stitched upon it in colored cloth. In taking the corona off, grasp it in the center, front and back, let the sides come together, and place it across the aparejo, back to the rear. The corona should be the same size as the saddle-blanket, and should neatly cover it, on the animal. See *Packing*.

CORPORAL.—The rank below that of Sergeant. In the British army, at present, Corporal is the grade next below non-commissioned officers. When the regiment is formed as a corps, he has no function different from the private soldier. In barracks or camp, however, he exercises certain disciplinary control over the privates. At present, in the British army, there are 32 Corporals to each regiment of cavalry, and 40 for each infantry battalion. They receive pay varying from 1*s*. 3*d*. to 2*s*. 5*d*. per day. The Lance Corporal is an assistant Corporal, who remains, however, on private's pay; he wears one *chevron* on his arm, and two when he rises to the rank of Corporal. In the United States army, a Corporal is the lowest officer in a company, standing between a private and Sergeant, and does duty in the ranks as a private, except that he places and relieves sentinels, and at drill has charge of a squad.

CORPORAL MAJOR.—In the British service, a troop Corporal Major is the non-commissioned officer of the highest rank in a troop of the Household Cavalry; his position and authority are the same as those of a Color-sergeant of infantry. A regimental Corporal Major is the non-commissioned officer of the highest rank in each of the three regiments of Household Cavalry, and corresponds to a Sergeant Major of infantry.

CORPORAL PUNISHMENT.—The infliction on the bare back, by means of a cat-o'-nine-tails, of a certain number of lashes for crimes committed by soldiers. Except for very grave offenses, such punishment is seldom resorted to in the army, and then only during war-time or on board ship. The number of lashes is limited to 50.

CORPORAL'S GUARD.—An expression used to indicate a detachment of several men under arms. It may be applied to a squad equal to that usually placed under the charge of a Corporal for drill, police, guard-duty, etc. Generally made use of in a derisive manner.

CORPS.—The Articles of War use the word *corps* in the sense of a portion of the army organized by law with a head and members; or any other military body having such organization, as the Marine Corps. A regiment is a corps; an independent company is a corps; a body of officers with one head is a corps, as the Topographical Engineers. Detachments of parts of regiments, or of whole regiments, united for a particular object, whether for a campaign or a part of a campaign, are not corps in the sense of the Rules and Articles of War, for such bodies have neither head nor members commissioned in the particular body temporarily so united; but the officers with such detachment hold commissions either in the corps composing the detachment, in the army at large, in the Marine Corps, or Militia.

A corps operating with an army should consist of three divisions of the line, a brigade of artillery, and a regiment of cavalry. If the corps is to operate independently, the cavalry force should be increased to a division. The same principles which govern the evolutions of a division are applicable to a corps. The commands of the General are communicated through his Staff-officers; they are general in their nature; embrace the particular formation he may desire for each division; the direction the line is to extend; the point where its right or left is to rest; and such further instructions as may be necessary to carry out his views. Orderlies for the Corps, Division, and Brigade Commanders are detailed from the infantry, and are mounted.

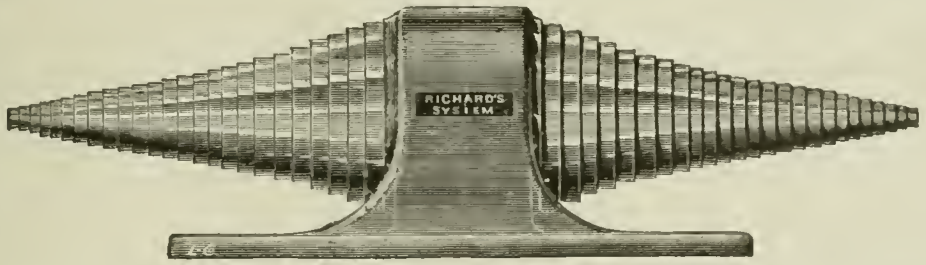
CORPS ARTILLERY.—A portion of the field-artillery left at the entire disposal of the Officer Commanding the Artillery, to employ in any manner required by the Corps Commander. It is sometimes termed *reserve-artillery*, and should consist of both light and heavy batteries. It fulfills two purposes—one to support the *divisional* guns, and the other to give the means of combining a large number of pieces as an *artillery mass* for a decisive effort either offensive or defensive.

CORPS D'ARMEE.—In the military system of the greater Continental European States, an organization of the forces in the time of peace. The whole military strength is divided into several corps, each complete in itself as an army, with everything needful for service, Staff and Artillery-park included. The English army is now distributed into eight army corps, stationed in eight territorial centers. The French army had in 1879 nineteen *corps d'armée;* which have been increased in strength by the recent military reorganization. Germany had in the same year eighteen *corps d'armée.* In the Austrian service the normal number of *corps d'armée* is thirteen. The military strength of Russia, as finally settled in 1876, is distributed over fourteen military districts. See *Army Corps.*

CORPS DES GUIDES.—A body originally formed in France in 1756, consisting of one Captain, one First Lieutenant, two Second Lieutenants, two Sergeants, two Corporals, one Anspessade, and twenty Privates, called the *Fusilier-guides.* Another Corps of Guides was also formed in 1796. This corps now forms part of the Imperial Guard.

CORPS OF ENGINEERS.—A Corps organized in the United States in 1802, to consist of one Colonel, one Lieutenant Colonel, two Majors, four Captains, four First and Second Lieutenants, and Cadets,—the whole number not to exceed twenty,—to be stationed at West Point, and to constitute a Military Academy. In 1838 the Corps was increased to forty-seven officers, and a Corps of Topographical Engineers in addition was organized, In 1846, Sappers, Miners, and Pontoniers (bridge-builders) were added. In 1861, at the beginning of the Rebellion, three additional companies were provided for, and one of Topographical Engineers was added. This company was disbanded in 1863, and its officers sent to the Corps of Engineers. At present the Corps has one Chief, six Colonels, twelve Lieutenants, twenty-four Majors, thirty Captains, twenty-six First Lieutenants, and ten Second Lieutenants; also the Battalion. The Corps is a special arm of the service, charged with the reconnoitering and surveying for military purposes; the selection of sites, the formation of plans, projects, and estimates for military defenses of every kind; the construction and repair of fortifications and defensible works of every description, whether temporary or permanent; the planning, laying out, and superintending all military works, defensive or offensive, of troops in the field, camp, or cantonment; the examination of all routes of communication by land or by water, both for supplies and for military movements; the planning and construction of military roads and bridges; the planning and execution of such works of river or harbor improvement, including sea-walls, breakwaters, and light houses, as may be assigned to it by law, or by the President of the United States; the collection, arrangement, and preservation of all reports, memoirs, estimates, plans, drawings, and models relating to the several duties above enumerated. All quarters for officers and soldiers, all workshops and storehouses required within the lines of permanent fortifications, are constructed by the Corps of Engineers as a part of the work. Until 1866 the Engineer Corps had the superintendence of the United States Military Academy at West Point, but since that year all branches of the service are admitted to their share of supervision. See *Engineering* and *Royal Corps of Engineers.*

CORRECTIVE GAUGES.—A device for testing and correcting fixed caliper-gauges, and also as a reference in any case to prove dimensions within its range; the disks are not constructed on what is termed the pyramid plan; each one is separate, ground independently to standard size, and tested by the measuring machine. The usual set, as shown in the drawing, is made to embrace forty-nine sizes, advancing by sixteenths from one fourth of an inch to two and one half inches, and by eighths to four inches, but can be furnished with any number of sizes up to any required diameter. See *Gauge, Measuring-machine,* and *Standard Scale.*



Corrective Gauges.

CORRESPONDENCE.—All official correspondence between the Heads of the different Departments of the Staff of any command and its Commander passes through the Adjutant General, Assistant Adjutant General, or Adjutant of the command, as the case may be. Communications to or from a Commander and those under his command pass through the Adjutant General, Assistant Adjutant General, or Adjutant on duty with it, excepting only such communications between a Disbursing Officer and the Chief of the Bureau in which he serves as relate exclusively to the ordinary routine of business in their own Department. All communications, reports, estimates, etc., from officers serving at a military post, as well as communications of every nature addressed to them relating to affairs at the post, pass through the Post Commander. All communications, whether from an inferior to a superior, or *vice versa*, are, as a general rule, to pass through the intermediate Commanders.

In cases of pressing necessity, which leave no time for regular communication, the necessity is stated. The same rule governs in verbal applications. A Lieutenant seeking an indulgence applies through his Captain, a Captain through the Adjutant, and so on. This, however, is not interpreted as including matters in relation to which the intermediate Commanders can have no knowledge, and over which they are not expected to exercise control or to express opinion. All communications from superior to inferior officers are answered through the same channel as received.

Officers cannot apply to the Secretary of War or General of the Army for personal favors, or address them on official matters in any other manner than is prescribed by Regulations and military usage. All such communications must be in writing, and addressed to the Adjutant General of the Army, through the intermediate Commanders. Applications made in any other mode than that above prescribed are not entertained, but are construed as a breach of discipline, subjecting the writer to arrest and trial for disobedience of orders. Generally officers who forward communications indorse on them their remarks or opinion, without other letters of transmittal. Official letters should generally refer to one matter only. Those transmitting rolls and returns should refer to no other subject. Applications for opinions or decisions upon questions relating to official business are not made by persons in the military service to the Judge Advocate General, or to officers connected with other branches of the Government, as the Attorney General, or officers of the Treasury Department, without first submitting such question to the Secretary of War through the regular channels. No officer is addressed in orders or official communications by any title other than that of his actual rank. All communications on public service are marked on the envelope "Official Business."

Whenever more than three pages of the sheet used are required for the body of the communication, an additional half-sheet, or more if necessary, is neatly pasted to the first sheet, so that the outer page may be left entirely blank. Letter-paper is folded in three, foolscap in four, equal folds, parallel with the writing. The inner edge of the sheet is the top when folded. The left-hand fold of the outer page is the first fold. The first fold is used exclusively for a brief analysis of the contents of the original communication, the office marks, and noting of inclosures. Indorsements commence at top of the second fold, and follow each other in regular order of date on successive folds, leaving room after each for office marks. In no case should a loose wrapper be placed around an official paper, except as a mere covering, on which nothing is to be written; but additional space for indorsements should be provided by neatly pasting slips of paper on the under side of the last fold—right-hand edge of the original paper—each slip to correspond in length and width (when pasted on) with the length and width of the original fold, and to turn back upon the last fold like the leaves of a book. By this arrangement the first fold on which the office marks and brief are made is always outside. Printed labels, by way of indorsement, are not pasted on the papers; they cause the folds to crack, and increase the bulk of the papers. All inclosures are numbered, and bear the proper office marks. Inclosures of the original communication are noted on the first fold, just below the brief. If others are added when an indorsement is made, the number of them is noted at the foot of their appropriate indorsement, and also on the first fold of the original communication, and to the latter notation is added the number of the indorsement to which they belong, thus: *One inclosure—Fifth indorsement*. Inclosures to indorsements are numbered in the same series as those to the original paper, and the number of the indorsement to which they belong is added below. If few in number and not bulky, inclosures may be kept inside the original paper. If otherwise, they will be folded together in a wrapper marked "Inclosures," as an accompanying package.

CORRIDOR.—The covered-way lying around the whole compass of the fortifications of a place.

CORROSION.—A species of dissolution of metallic bodies either by an acid or a saline menstruum. Cannon-metals should be able to resist the corroding action of the atmosphere, and the heat and the products of combustion of the powder; should be susceptible of being easily bored and turned; and should not be too costly, on account of the very great number and weight of cannon required for the military service.

CORROSIVE SUBLIMATE.—A laboratory substance described as the bichloride of mercury. It is formed by introducing hot mercury into chlorine gas; the mercury inflames and the bichloride is formed. There are other ways of preparing it. What is termed kyanizing is applying this substance to the preservation of timber, cordage, sails, tent-cloths, and other fabrics from decay by mold, or by the ravages of insects. This mode of preserving the articles mentioned is the invention of Mr. Kyan.

CORRUGATED IRON.—Common sheet-iron, and what is improperly called "galvanized-iron" (i.e., sheet-iron coated with zinc by immersion in a bath of the fused metal), have of late been made available for many useful purposes, by virtue of the great additional strength imparted to the sheets by corrugation, which is merely an application to metallic substances of the old contrivance of "goffering or crimping," by means of which the frills of the olden time were made to keep their shape. The sheets of metal are passed between rollers, the surfaces of which are formed into rounded grooves and ridges, the ridges of one roller filling the grooves of the other. The metal in passing between these is compressed into a waving form, or corrugated. It will be easily understood that a piece of sheet-metal, of given size and thickness, if rolled up to form a tube, will resist a much greater bending strain than when flat. Now the curves of the corrugation may be regarded as a series of half-tubes, and the additional strength is due to the application of the same principle. Walls and roofs of temporary buildings are now extensively made of this material. Railway-sheds, emigrants' houses, temporary churches, store-rooms, and sheds for dock-yards, etc., are among the common applications. Mr. Francis, of New York, has applied the principle to the construction of light boats, the strength of which, and their power of resisting violent blows, such as boats are subject to on landing through a surge, is said to be remarkably great. On this account they are proposed to be used for life-boats, ships' boats, etc. They are made by stamping the metal in enormous dies, of the shape and size of the boat, and grooved for the required corrugations. Small boats thus constructed require no internal bracings, the requisite rigidity and strength being given entirely by the corrugations.

CORSELET.—A small cuirass, or piece of armor to cover the front of the body, worn formerly by pikemen. See *Armor*.

CORSEQUE.—The common name of the *ranseur* in France. See *Ranseur*.

CORSESCA.—A kind of spear used in the sixteenth century. Now obsolete.

CORSO.—An Italian word used to express not only the racing of horses (without riders), but also the slow driving in procession of handsome equipages through the principal streets of a town, such as almost always takes place in Italy on festivals. This custom has given a name to many streets in almost all the larger towns of Italy. The best known of these is the Corso in Rome, which is the scene of the celebrated diversions of the carnival.

CORTEGE.—The official staff, civil or military; a train of attendants. See *Triumph*.

CORUNDUM.—A hard mineral consisting of crystalline alumina. The sapphire and ruby are allied substances of different colors. Corundum is used in powder of varying fineness; is made up into wheels and laps with gums, resins, glue, etc.; and is employed in the armory in the form of cones, cups, files, slabs, wheels, laps, bobs, points, and tapes.

COSIGNE.—The French expression commonly used for the parole or countersign.

COSSACKS.—A people inhabiting those parts of the Russian Empire which border on the northern dominions of Turkey, Poland, and the southern confines of Siberia. Both the name and origin of this people are involved in great uncertainty. They seem to have none of the national characteristics of the Russians, and are probably a mixed Caucasian and Tartar race. They form a sort of independent republic, paying no taxes to Russia, but cheerfully contributing their numerous and valuable contingent of men, who are well known as the most harassing light troops that ever exercised a predatory warfare in the train of any army.

COSTON SIGNAL-LIGHTS.—These consist of red, green, and white lights and their various combinations, representing the different numbers and pendants. The colors assimilate as far as possible with those of the day-flags. The case is made of fuse-paper 3 inches long and 1¼ inch in diameter. A cylindrical block of soft wood ½ inch long forms the bottom, with a wooden nipple attached to fit into the signal-holder or firing-pistol. Through the center of the bottom is a small hole with a thin copper tube $\frac{3}{16}$ inch in diameter, extending through the middle of the case to within ¼ inch of the top. Hollow drifts are used in filling, which are struck fifteen moderate blows with a half-pound mallet for each charge. The case is filled to the top of the copper tube; the last charge being ¼ ounce of mealed powder. A small strand of quick-match is put through the copper tube and wooden bottom, the upper end stitched to the side of the paper case above the mealed powder, and the lower end split to make sure of its ignition by the cap from the pistol. The top of the case is covered with a thin wafer of brown paper immediately over the quick-match and mealed powder; then over all is a pasteboard top with a rim secured to the body of the case by a strip of paper pasted on the two. The wooden bottom is covered with shellacked paper. The signal is finally covered with white, red, or green paper, according to the color of the composition, and packed in laboratory-boxes for issue.

The several colors in the Coston signals are intended to burn from 8 to 10 seconds. In a signal composed of three colors 1½ charges of the composition of the last color to be burned are put in first and driven; a thin circular disk of paper is put in the case on top of this composition, then 1½ charges of the second color are put in and driven, a piece of paper put on, and then 1½ charges of the first color to be burned are put in and driven.

When a signal is composed of but two colors, the lower third of the paper case is filled with powdered clay, and driven the same as the composition, then on top of this clay the second colored composition is driven, and on that the first. When but one color forms a signal, two thirds of the case is first filled with clay, and the composition driven in the upper third. The following compositions are used for Coston signals:

For the white signals—5 parts sublimate of sulphur; 5 parts sulphuret of antimony; 2 parts red oxide of lead; 3 parts sulphuret of arsenic; ½ part bleached shellac; 24 parts nitrate of potash.

For the red light—16 parts chlorate of potash; 6 parts oxalate of strontium; 2 parts bleached shellac; 2 parts sugar of lead; ½ part desiccated lamp-black.

For the green light—4 parts chlorate of mercury; 2 parts bleached shellac; 12 parts chlorate of barium. See *Signal-rocket*.

COTICE.—In Heraldry, one of the diminutives of the bend. It is a fourth part of the bend, and is usually borne in couples with a head between. Sometimes written *Cost*. See *Heraldry*.

COTTON WASTE.—The refuse cotton collected in cotton-mills. It is used for wiping machinery, and should be put away with care in some out-of-the-way place when the work of the day is over, or saturated in water with a solution of soda and boiled, when the oil will be extracted. In its oily state with particular oils, such as vegetable-oils, it is liable to spontaneous combustion, and should not therefore be left about. It is very dangerous, as will be realized, to leave it in houses where gunpowder is manufactured. It is not at all unlikely that the explosion in many gunpowder-houses, the reason of which has been unknown, has been caused from cotton waste containing oil having been left in the houses at night, and thus ignited the building or buildings. In some cotton waste itself there are the elements of fire.

COUCHANT.—In Heraldry, a beast lying down, and with his head up, is *couchant*. If the head is down, he is *dormant*. See *Heraldry*.

COUDIERES.—Small plates of metal, of various shapes, fixed together by straps and buckles, over the mail, in order to give an increased security to the elbows.

COULLART.—A military instrument of war used in the early part of the fifteenth century for the purpose of casting great stones.

COUNCIL OF ADMINISTRATION.—A Board of Officers periodically assembled for the administration of certain business matters. In the United States service, the Commanding Officer of every post, at least once in every two months, on muster-days, convenes a *Post Council of Administration*, to consist of the *three* regimental or company officers next in rank to himself; or, if there be but two, then the *two* next; if but one, the *one* next; and if there be none other than himself, then he himself acts. Regimental Councils of Administration consist of the three officers of the regiment on duty at headquarters next in rank to the Commander. The junior member records the proceedings of the Council in a book, and submits the same to the Commanding Officer. If he disapprove the proceedings, and the Council, after a reconsideration, adhere to its decision, a copy of the whole is sent by the Officer Commanding to the next higher Commander, whose decision is final, and entered in the Council-book, and the whole is published in Orders for the information and government of all concerned. The proceedings of Councils of Administration are signed by the President and Recorder, and the Recorder of each meeting, after entering the whole proceedings, together with the final order thereon, deposits the book with the Commanding Officer. In like manner, the approval or objections of the Officer ordering the Council are signed with his own hand. The Post Council prescribes the quantity and kind of clothing, small equipments, and soldiers' necessaries, groceries, and all articles which the Post Traders may be required to keep on hand; examines the Post Traders' books and papers, and fixes the tariff of prices of the said goods or commodities; inspects the Post Traders' weights and measures; fixes the laundress' charges, and makes regulations for the Post School. Councils of Administration at posts occupied by companies of the same regiment, at regular meetings, set aside and cause to be paid over to the regimental treasurer fifty per cent of the amount accruing to the post fund during the preceding two months after deducting the expenses of the bakery. This amount is carried by the Regimental Treasurer to the credit of, and will constitute, the regimental fund. When a post is garrisoned by companies of different regiments, the Council makes an equitable division of the sum allotted to the regimental fund, and causes the sum belonging to each regiment or corps to be paid over to its Treasurer. In case of the loss of regimental, post, or company funds, the circumstances of the loss are carefully investigated by the Council of

Administration, and reported with a recommendation as to the responsibility, through the proper channels, to the Adjutant General, for decision by the Secretary of War.

COUNCIL OF WAR. A conference of officers, in military or naval warfare, on some matter in which the Commander wishes to fortify his judgment by an appeal to that of others. The French make a special provision for a Council of Defense in a garrison. The Governor or Commandant may summon the Heads of Departments to meet him in consultation whenever he may think such a step desirable; and the opinions expressed at such meetings are placed upon record. The Commandant of a garrison generally solicits the opinion of a Council of War before surrendering to besiegers. The English Military Code leaves these matters to the discretion of the Commander.

COUNTER-APPROACHES.—With a strong, well-disciplined garrison, skillfully commanded, one of the most efficient auxiliary means of defense is to be found in counter-approaches from the main defensive works on the point of attack, towards the position of the besieger's lines. These consist of simple trenches pushed forward from the most advanced works as far as can be safely done with a view of obtaining enfilading and reverse fires, both of artillery and infantry, on the trenches and batteries of the besiegers. The front to be occupied by the counter-approaches, the distance to which they should be pushed forward in advance of the main works, and the direction they should receive will depend upon the natural features of the site, the positions and strength of the besieger's works, and the bearing of the main defensive works upon the ground over which the counter-approaches must be run.

The portions of the besieger's works that the counter-approaches can be made most effective against are his batteries and his boyaux of approach. Positions, therefore, should be given to the counter-approaches, and a sufficient front to obtain enfilading and slant reverse views on the boyaux with artillery and musketry, and a fire of Sharp-shooters on the batteries, with a complete view of the ground in advance of them, not obstructing, however, the fire of the main defenses. The trenches by which they are connected with the defensive works should be enfiladed by these, and should be so run that the retreat of the troops through them shall not be liable to be cut off, whilst they should offer a convenient and short line of communication. To prevent them from being of immediate use to the besiegers, if carried by open assault, the reverse of the trenches, even of those which are enfiladed from the main defensive line, should receive a gentle slope to the rear to enable the trench to be swept by a slant or even direct fire from the works in the rear. If good positions can be found for them, the counter-approaches should be supported by strong field-works; otherwise stockaded keeps for small detachments may be made at suitable points to assist in repelling any open assault of the besiegers.

From the most advanced line of the counter approaches, picked men may be sent forward to occupy good positions to annoy the artillerists and working parties of the besiegers by taking shelter behind any cover from fire or by digging holes, from which, by throwing the earth in front, they can speedily gain cover. These holes may be gradually enlarged so as to contain three or four men each, who can be readily rallied for mutual support against open assaults by small detachments of the besiegers, or for small sorties against their workmen. The counter-approaches will also be used for positions for movable batteries of light rifled guns, which can be shifted from point to point during the day, wherever they can best annoy the besieger's works and find cover, and be withdrawn at night to secure them from the danger of capture. During this period the Engineer Officers and workmen are employed in organizing the point of attack for a vigorous defense. The covered-ways are palisaded with care. Tambours, or block-houses, are established in the salients of the most advanced and exposed outworks, and also in the re-enterings, where guards are constantly posted. See *Approaches.*

COUNTER-ARCH.—In fortification, a vertical arch connecting the tops of the counterforts.

COUNTER-BATTERY.—A battery employed to dismount or silence, by direct fire, the guns of an enemy's works. In such a battery the interior crest should be nearly parallel to the line to be counter-battered. A position somewhat oblique to the line, so that the shot of the battery may enter the embrasures obliquely, is also a good one for tearing away the cheeks of the embrasures and exposing the guns of the defenses. Whenever a position has to be taken up for an enfilading or a counter-battery, in which the direction that can be given to the interior crest is very oblique to that which it ought to receive, it will be necessary to make the embrasures of the battery with a corresponding obliquity to the direction of the parapet; but to avoid the inconvenience of these embrasures when very oblique, it will be necessary to break the interior crest into a serrated line, to allow the muzzles of the guns to be run the requisite distance into the embrasures; placing one side of the indent perpendicular to the axis of the embrasure, and the other parallel to it.

For ricochet, the batteries are best armed with smooth-bore 18- and 24-pounders and 8-inch howitzers. The fire of the guns is mainly directed against the artillery of the defenses; that of the howitzers to sweep the covered-ways and ditches, to destroy the palisadings and the traverses by the explosion of the shells that may lodge in them. As a general rule, there need not be more than seven pieces, nor should there usually be less than three in any one battery; the number depending upon the bearing which the artillery of the part to be silenced may have upon the ground on which the works of the besiegers must be placed. The batteries should be as far asunder as practicable, so as not to invite a concentration of the fire of the defenses upon any point, by the accumulation of a large number of pieces on it, and thus multiply the chances of the loss both to the troops and *matériel.*

The greater part of these batteries will occupy fixed positions during the time they are in use, and which, as has been stated, will depend upon the positions occupied by the artillery of the besieged. Other batteries of lighter caliber, which can be easily shifted from point to point, as the exigency may require, can be used in combination with these, by taking advantage of any natural covers, or by throwing up slight parapets like those in ordinary field-works. For batteries of rifled guns, with long ranges, the guns may safely and advantageously be placed in barbette. For positions within more certain range of the besieged works, the guns should be placed in embrasures more or less open according to the field of fire desired. See *Batteries* and *Enfilading Battery.*

COUNTER-CHANGED.—In Heraldry, when several metals and colors are intermixed, one being set against the other, they are said to be counter-changed.

COUNTERFORT.—In fortification, a mass of stone or brick work added to the revetment of a rampart, in such a way as to form a buttress for resisting the pressure of the mass of earth. Counterforts occur at intervals of about twenty feet, and assist in preventing the earth from pushing down the revetment-wall into the ditch. When properly constructed, counterforts very effectually enable the walls to resist the shock of distant artillery. They have been made *dovetailed, rectangular,* and *diminished.*

COUNTER-GUARD.—1. An outwork designed to defend the two faces of a bastion or ravelin from a direct fire, so as to retard a breach being made. The counter-guard consists of two lines of rampart parallel to the faces of the bastion or ravelin, and separated from them by a narrow ditch. The crest of the counter-guard must be some three feet lower than that of the works it covers, in order not to obstruct the defense. Lest the enemy should establish a battery on the counter-guard, the terre-plein, or flat space behind its parapet, is made very narrow. Noizet speaks of the counter-guard as a valuable, and sometimes a necessary, element of a front; preferring it in some cases to the demi-lune. Like all other outworks, when used, it should be flanked by the enceinte flanks, be swept on the interior by the fire of its faces, and not intercept their fire on the ground in advance of it. Vauban, in his third method, forms his enceinte with a high scarp-wall, of the same dimensions and form as in his first method; and he procures his flanking arrangements for the enceinte by small bastioned towers of masonry, which are casemated in the lower story, and have an open battery in the upper, covered by a masonry parapet. This enceinte he covers with spacious counter-guards of the form of lunettes, the faces, flanks, and gorges of which are revetted, and which cover the bastioned towers of the enceinte; and between the flanks of these counter-guards, and covering the curtain of the enceinte between the bastioned towers, he places a tenaille. A demi-lune, in the form of a lunette, is placed in front of the counter-guards and tenaille; within which he has placed a redoubt with a revetted scarp and counterscarp. The whole of this combination of outworks he incloses with a covered-way arranged in the usual manner. Cormontaigne uses the counter-guard only as an exceptional outwork; and has applied it, in some of the works constructed by him, to strengthen a point that would otherwise have been too weak; but not, as by Vauban, as a constituent part of his method. Two of the most eminent modern Engineers, Coehorn and Carnot, in their methods, use earthen counter-guards to cover their enceintes, giving them only sufficient thickness at the top for a parapet and a banquette for infantry; so that, being taken by the assailant, he will not find sufficient room to place a breach-battery upon their terre-pleins against the enceinte. In this way they serve chiefly as masks or face-covers to the enceinte-faces. Haxo forms of the counter-guard a constituent element of his method, giving it, like Vauban, the form of a lunette. See *Outworks*.

2. A plate of metal, flat or concave, plain as in open work, found on the side of the barrel (and perpendicular to its axis) in swords of the sixteenth century.

COUNTER-HURTERS.—In gunnery, pieces of iron bolted to the rails on which the gun-carriage moves to check it in front and rear.

COUNTERMAND.—To revoke, as a former command; to direct or order in opposition to an order previously given, thereby annulling it or prohibiting its execution.

COUNTERMARCH.—An evolution by which a body of men change front, and at the same time retain the same men in the front rank. On the same principle, a whole army will sometimes change front. If after the countermarch the order *about face* be given, the same front will be preserved, with the rear rank in front, and what was previously the right now serving as the left. A rear rank may also become a front rank by merely countermarching round the end of the latter, which remains stationary.

To place a piece of artillery and its caisson in the same relative positions on the ground they occupied before, but facing in the opposite direction, the Instructor commands: 1. *Countermarch*, 2. MARCH. At the command *march*, the leading carriage reverses, and moves at once to the position occupied by the rear carriage at the beginning of the movement; the rear carriage follows the track of the leading one, reverses on the same ground, and preserves its distance. On the completion of the countermarch, the section moves forward in the new direction. To halt the section upon the completion of the countermarch, the Instructor commands: 1. *Section*, 2. HALT. The command *halt* is given when the heads of the lead-horses of the leading carriage reach the position occupied by the hind part of the rear carriage at the beginning of the movement.

COUNTERMINES.—Galleries or chambers excavated under the glacis or some other part of a defense-work of a fortress. Their purpose is to foil a besieger. In a fortress on a large scale there are enveloping-galleries, counterscarp-galleries, listening-galleries, galleries of communication, and other subterranean passages, under various parts of the outworks, all for the purpose of assisting the defenders in discovering and frustrating plans laid by the besiegers. Listening-galleries are sometimes pushed forward even to the foot of the glacis. In such places selected men put their ear to the ground, and listen for the approach of the enemy, as denoted by the sound of tools used in driving a mine or gallery of attack. The sound of a pickaxe so employed can be heard through the ground at a distance of 60 feet. As there are no openings above, these galleries cannot be driven beyond a certain distance, as the sappers would be stifled for want of air. If a mine be driven to blow up the defense-works, a countermine is driven to blow up the besiegers; and sometimes the two parties carry their works so far as to meet in the subterranean passages, and there fight. If there be only a thin wall of earth left between them, they will fire pistols through bored holes, or drive in cartridges or smoke-balls. This terrible work is mostly carried on by sappers and miners.

The systems of countermines proposed by most writers on this branch of the defense are generally of too complicated a character to admit of being executed at a reasonable cost, and they require for their service not only a large amount of powder, but also a great number of miners. The following arrangement has been proposed to meet in a simple and satisfactory manner the requisites of a subterranean defense: Parallel to the capital of an assailable salient of the work, four listening-galleries may run out to a distance from 50 to 80 yards beyond the salient; the interval between these galleries being twice the line of least resistance of the heaviest charged mines. If we take this line at 7 yards, or 21 feet, which is about the greatest for common mines, the interval of the galleries will be 15 yards. The dimensions of the listening-galleries for about the first 20 yards may be those of a grand gallery, and the remaining part may be a common gallery. These galleries will depart from a transversal grand gallery about 6 yards in advance of the counterscarp at the salient, which will serve as a communication between them, and also as a depot. Other transversals of the size of half-galleries, or branches, will be made at different intervals for the purpose of ventilation. This group of galleries will have their outlet into the ditch, through two galleries, one leading from each extremity of the transversal grand gallery.

To flank this group, other listening-galleries may extend obliquely outwards from the two outside parallel galleries. To serve the mines of this group, a series of ascending branches may lead from the galleries to chambers, placed midway between the galleries, and having a line of least resistance of 4 yards. This will place these chambers at about 8 yards from the two adjacent galleries. Smaller branches may lead, if necessary, from these last branches to other groups of chambers having a line of least resistance of 2 or 3 yards. A series of chambers with lines of least resistance of 7 yards will be established in juxtaposition with each listening-gallery. From this arrangement it will be readily seen that ground over the mines can be entirely broken up, and that the successive explosions of the mines of one group will destroy the branches and galleries which lead to them, without injuring those of other groups. The object of this disposition is to blow up by repeated explosions the ground over which the enemy must approach upon the assailed salient. Groups of galleries and mines similar to the one in advance of the salient may be arranged for the defense of the interior of the work at the salient. As the air in the galleries of mines is liable to become foul from various causes, some mechanical contrivances and chemical methods by which the vitiated air can be removed and fresh air introduced have to be resorted to for the purpose of enabling the miners to circulate through them with safety. Air-pumps, bellows, and artificial draughts, procured by kindling a fire at one of the outlets of a system of galleries, are the ordinary expedients by which this object is attained.

The great pecuniary outlay requisite in establishing a system of galleries, the time and labor for their construction, besides the large corps of experienced miners and the extra provision of powder demanded for their efficient service when the system embraces any considerable extent of surface, has led Engineers to consider whether the end proposed by subterranean means of defense might not be attained by some more simple expedients. Since the application of galvanic currents to exploding mines, and the facilities which it affords to effect this at very considerable distances, it has been proposed to substitute isolated shafts for

Countermining Operations at Siege of Sebastopol.

galleries, placing them in positions most suitable to attain the besieger's works. The shafts, to give them a character of permanency, may be lined with masonry and receive a stone or iron cover, which may be concealed from view by placing it several feet below the surface. When wanted for service, the shafts are charged and tamped in the usual manner, and connected with a galvanic battery by insulated wire conductors, laid sufficiently far below the surface of the ground to be without the sphere of the besieger's excavations and of other accidents.

We find remarkable countermining operations at the siege of Sebastopol. There the French had to work under far more unfavorable circumstances than the Russians; the system of countermines of the latter being well ventilated by shafts sunk in the ditch of bastion No. 4, and others in the glacis, and also being below strata of a hard limestone rock, and the French, moreover, having a greater distance to push their galleries to reach the Russian countermines than these were from their defensive works in their rear. With these disadvantages, the French resolved, about March 14, 1855, to break up sufficient ground between their third parallel and the ditch of bastion No. 4, by a connected series of mines, to give them front enough for a fourth parallel, which was to contain troops to cover their further mining operations. All of their subsequent mining labors on this point, up to the close of the siege, tended to this object; and at this period the effect of their arduous labors is shown in the drawing. A is the salient of bastion; B, bottom of ditch and entrance to countermines, C, C; D, D, crater formed by explosions of French and Russian mines; E, E, French galleries of attack; F, third parallel from which French attack was made; G and H, communications between third parallel and French trenches in and around the borders of crater, D, D, D. During these operations the French executed about 100 feet of ramps and shafts, and about 4000 feet of galleries and branches. They exploded six undercharged mines and camoutlets; twenty stone fougasses; thirty-five over-charged mines; and sixty-four over-charged shafts: making a total of one hundred and twenty-five explosions; using in all about 130,000 pounds of powder. Their losses in killed, in wounded from momentary suffocations, and in those rescued after having been buried alive, among their own miners and some auxiliary force from the infantry of the line, were two hundred and twenty-eight in all; of which eight were officers, killed either in the mines or trenches by explosions, and eight by the Russian fire. Not only did the French use their mines to gain a footing for their fourth parallel, but they were obliged to resort to the same means to open, in the rock, communications between these two parallels. See *Blower*, *Gallery*, and *Mines*.

COUNTER-PAROLE.—A word given in any time of alarm, as a signal. See *Parole*.

COUNTER-PASSANT.—In Heraldry, a term for two beasts passing each other the contrary way.

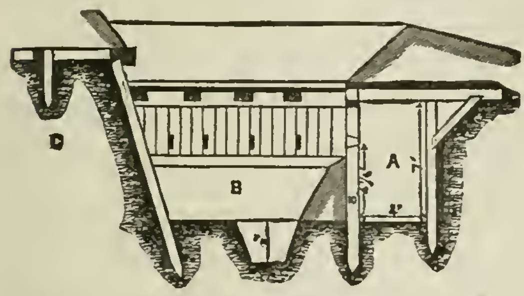
COUNTERPOISE-CARRIAGE.—A sort of carriage which, applied to a gun mounted in *barbette*, allows it to recoil behind the parapet or other shelter, and by means of a counterpoise brings it, or assists in bringing it, again into *battery* after it has been loaded. In the Moncrieff carriage the counterpoise is a heavy weight between the cheeks of the top carriage. In the King carriage the weight is in a well under the pintle block, and is attached to the carriage by a wire cable.

COUNTER-ROUND.—A body of officers whose duty it is to frequently visit and inspect the rounds and sentinels.

COUNTERSCARP.—The side of the ditch opposite to the parapet. The slopes of the scarp and counterscarp will depend on the nature of the soil, and the action on it of frost and rain. The scarp is less steep than the counterscarp, because it has to sustain the weight of the parapet. It is usual to give the slope of the scarp a base equal to *two thirds* of the base of the natural slope of a mound of fresh earth whose altitude is equal to the depth of the ditch; the base of the counterscarp-slope is made equal to *one half* the same base.

To determine the exact dimensions of the ditch for a given parapet requires a mathematical calculation. On the field a result may be obtained approximating sufficiently near the truth for practice, by assuming the depth of the ditch and dividing the surface of the profile of the parapet by it to obtain the width. In excavating the ditch it will be found that more earth will be furnished at the salients than is required there for the parapet; and that the re-enterings will not always furnish enough. On this account the width of the ditch should not be uniform, but narrower at the salients than at the re-enterings. See *Scarp*.

COUNTERSCARP-GALLERY.—The counterscarp-gallery consists of a framework, covered on top with a sheeting, which is placed within the counterscarp at the salients. The front of the gallery is made of nine- or ten-inch scantling, placed upright, and arranged with loop-hole defenses; these pieces are connected at top by a cap-sill. Cross-pieces are notched on the cap-sill about three feet apart; they are supported by shores placed four feet from the front piece. The cross-pieces may project three feet beyond the shores, and, if necessary, be braced from the shores. The gallery is covered on top by 1½-inch sheeting; and behind in a similar manner, but only to the height of five feet above the bottom.



A, Section; B, Elevation of a Counterscarp-gallery for a Work with a Revetted Scarp, C.

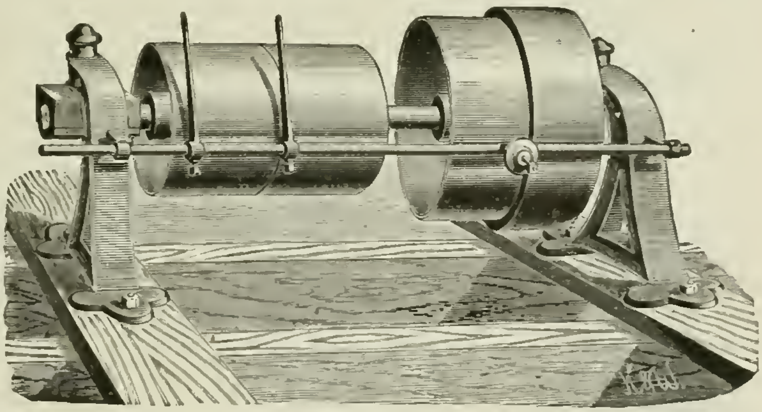
This arrangement gives a free space behind the back sheeting for the play of the rammer in loading. The height of gallery may be only seven feet; its width, according to the foregoing arrangements, is four feet. It should be covered on top by at least three feet of earth. The level of the gallery should be the same as the ditch; and there should be a small ditch in front of it, to prevent the enemy from closing on the loop-holes, or obstructing their fire by filling the ditch in front of them by means of sand-bags, fascines, etc. The entrance to the gallery is by a narrow door. See *Scarp-gallery*.

COUNTERSCARP-WALL.—A revetted counterscarp is regarded as adding to the difficulty of descending into the ditch, and as offering greater security against an open assault. For this purpose the wall should not be less than 12 or 15 feet in height to offer a serious impediment; in any case, where motives of economy do not imperiously demand it, the counterscarp-wall of the enceinte should be from 18 to 24 feet in height. This height will not only give great security to the ditch, but, as will be seen in the description of the siege-works of the assailant, it will delay considerably his progress, as the gallery by which he must generally reach the bottom of the ditch from the level of the covered-way terreplein is one of the slowest and most laborious of his operations.

Besides giving greater security against a surprise, a revetted counterscarp enables the assailed to circulate through their ditches even when the assailant has established his trenches along the glacis-crest, as the top of the counterscarp-wall will screen the troops passing along the bottom of the ditch. It also affords facilities for forming a counterscarp-gallery behind it, loop-holed for the defense of the ditch in an open assault, which, for small works without thorough flanking arrangements, will be found very serviceable. Besides, this gallery will be found of great utility where a system of defensive mines is to form a part of the defenses. But as counterscarp-galleries, if seized by the assailant, may be turned against the defenses, it is important that they should be placed in positions where they will be of little value to the assailant if seized by him.

The necessity for revetting with a wall of masonry the scarp and counterscarp of a wet ditch in which the water can be retained at a level of six feet in depth is not so obvious; as when the ditch is wide the obstacle of the water alone would seem to be sufficient to secure the place from a surprise. Many works under this condition have been built with simple earthen scarps and counterscarps; in some instances a chemin-de-ronde being formed by leaving a wide berm between the foot of the exterior slope and the crest of the scarp, and planting a loop-holed stockade near the crest. But in rigorous climates, where the water freezes quickly, a wet ditch is no longer a security in winter; and a revetted scarp of at least 24 feet in height, with a steep earthen counterscarp, is a better security against a surprise than the expedients proposed of keeping an open channel along the middle of the ditch of 12 feet in width, piling up on each side of it the ice taken from the channel, and throwing water over the exterior slopes to freeze and form a slippery surface to an assaulting column. See *Scarp-gallery*.

COUNTER-SHAFT.—An opposite and parallel shaft driven by band or gearing from the former one. The drawing shows the counter-shaft which accompanies the Tanite Company's large No. 5 wheel emery-grinder, much used in armories. The counter-shaft may be overhead, or it may receive the impulse from below. The Pratt clutch is generally applied to the counter-shaft. This clutch is unsurpassed in ease of working, freedom from binding, durability, and readiness of adjustment. The shipper-slide has no transverse strain; the clutch-jaws cannot become bound; the contact of the surfaces to produce motion is perfect; there is no shock in starting or reversing—no sudden tension of the belts, or undue strain upon the shipper-handle. Counter-shafts with this clutch may or may not be provided with cones. The Pratt friction-pulleys are furnished with sleeves and collars for adaptation to many machines where instantaneous starting and stopping is desirable. A threaded shoe is furnished with the collar, by means of which the attachment may be made to an ordinary straight shaft, by threading the shaft a length slightly exceeding the thickness of the collar.



Counter-shaft.

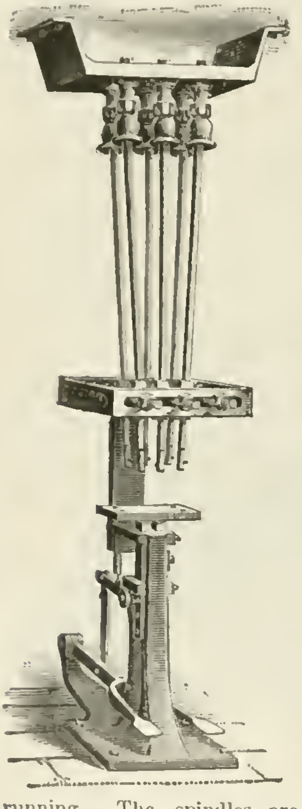
Supposing we have a main shaft running 110 revolutions, and a 12-inch hand-lathe counter-shaft with 8-inch tight and loose pulleys running 220 revolutions, we can find the following elements in a very simple manner: 1. To find the size of the pulley on the main shaft, multiply the diameter of the pulley on the counter-shaft by its number of revolutions and divide the product by the number of revolutions of the main shaft. The quotient will be its diameter:

$8 \times 220 = 1760, \frac{1760}{110} = 16$ inches diameter. 2. To find the number of revolutions of the counter-shaft, multiply the diameter of the pulley on the main shaft by its number of revolutions and divide the product by the diameter of the pulley on the counter-shaft:

$16 \times 110 = 1760$, $\frac{1760}{8} = 220$ revolutions. 3. To find the size of the pulley on the counter-shaft, multiply the diameter of the pulley on the main shaft by its number of revolutions and divide the product by the number of revolutions of the counter-shaft: $16 \times 110 = 1760$, $\frac{1760}{220} = 8$ inches diameter.

COUNTERSIGN.—A watchword or number given daily in time of war by the Commander of an army to the force under his command, in order that friends may be distinguished from foes; it is exchanged between guards, and intrusted to those employed on duty in guarding the camp or garrison. Before the enemy, the countersign must be given by every one who approaches a sentry's post, otherwise he will not be permitted to pass. See *Parole*.

COUNTERSINK.—An enlargement of a hole to receive the head of a screw or bolt. The sides of the hole are merely chamfered if the hole is to receive the head of an ordinary wooden screw. When a flat-headed screw or the head of a bolt is to be let in flush with or below the surface, a flat bottom is required. The countersinking-machine is quite a useful one in the arsenal and armory on general work such as strap- and T-irons, metal plates, harness, books, etc., where several holes are to be made, on a regular or irregular line, as each piece can be drilled and countersunk at one operation. The engraving represents six spindles; but the apparatus may be provided with any number required, according to the work to be done. The drills can be adjusted very close to each other, or several inches apart, even while the machine is running. The spindles are suspended from a frame fastened to the ceiling, and power is applied to the upper ends by means of belts from horizontal counter-shafts. The engraving shows but one table-slide; some countersinking-machines have two tables, with which the operator can do two different kinds of work at once if desired, or he can use all the spindles on one table.



A very convenient countersink and drill combined is so constructed that the countersink follows the drill, and the job is finished at one operation, saving the adjusting of work and tools twice. The countersink is so shaped that it may be readily ground when dull, and is finished with round shanks either ½ or $\frac{41}{64}$ inch diameter.

COUNTER-SWALLOWTAIL.—In fortification, a kind of outwork very much resembling a single tenaille. See *Swallowtail*.

COUNTER-TRENCHES.—Trenches made against the besiegers, which consequently have their parapets turned against the enemy's approaches, and are enfiladed from several parts of the place on purpose to render them useless to the enemy if he should chance to come into possession of them. See *Counter-approaches*.

COUNTER-VAIR.—An heraldic fur. It differs from *vair* by having its cups or bells of the same tinctures placed base against base and point against point. The tinctures are *or* and *azure*. See *Heraldry*.

COUNTERVALLATION.—In military engineering, a chain of posts constructed by the besiegers of a fortified place; it completely surrounds the place at a certain distance, and is intended to prevent sorties of the besieged. The posts are generally small redoubts, either isolated or connected by a line of earthworks. It is only during very protracted sieges that countervallations are constructed. They bear a certain relation to circumvallation.

COUNTER-WORKS.—Works undertaken for the purpose of destroying or rendering useless those of an enemy. See *Counter-mines*.

COUNTRY.—The region outside of a fort down to which the glacis slopes. See *Site*.

COUP DE MAIN.—A sudden and vigorous attack for the purpose of instantaneously capturing a position. See *Charge*.

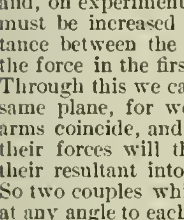
COUP DE POING.—A small pistol with a wheel-lock, invented in the sixteenth century. It is made entirely of iron, and the barrel is about 6½ inches in length. It is called *terzerol* in Germany.

COUP D'ŒIL.—The art of distinguishing by a rapid glance the weak points of an enemy's position, and of discerning the advantages and disadvantages offered by any given space of country, or selecting with judgment the most advantageous position for a camp or battle-field. Experience is a great aid in the acquisition of this necessary military faculty, but experience and science alone will not give it.

COUPED.—A term in Heraldry, used to describe the head or any limb of an animal cut off from the trunk, and smooth. It is distinguished from *erased*, i.e., forcibly torn off, and therefore ragged and uneven. A distinction is also made between *couped* and *couped close*, the latter signifying that the head or limb is cut off close, leaving no part of the neck or trunk attached to it. When crosses, bars, bends, and the like, are cut so as not to touch the sides of the escutcheon, they are also said to be couped. See *Heraldry*.

COUPE-GORGE.—This term, literally meaning *cut-throat*, is used in a military sense to signify any spot or position which affords an enemy so many advantages that the troops who occupy it must either surrender or be cut to pieces.

COUPLES.—The name given in statics to pairs of equal parallel forces acting in opposite directions, and at different points of a body. It is shown in the article PARALLEL FORCES that when two parallel forces act in opposite directions on a body, they may be replaced by one equal to their difference acting parallel to them in the direction of the greater, at a point *not* between but *beyond* the points where they are applied; and which point recedes the further from their points of application the nearer they approach equality, getting to an infinite distance when they become equal, and when their resultant accordingly is zero. In this limiting case the forces constitute a couple; they have no tendency to *translate* the body; their action goes wholly to make it rotate about an axis passing through its center of gravity, and perpendicular to the plane in which the couple acts. Such being the case, a couple cannot be replaced or counteracted by any single force, for such a force would produce translation; it can only be replaced or balanced by other couples. The length of the straight line which meets the lines of action of the forces at right angles is called the "arm" of a couple, and the product of the force into its arm is called its "moment." Most of the leading propositions in the theory of couples are readily seen to be true, as soon as they are stated. For instance, as the axis round which a couple tends to make a body rotate passes through the body's center of gravity perpendicularly to the plane of the couple, it does not matter what position the couple occupies in its own plane. Also, supposing the body to be rigid, the couple may be moved into any plane parallel to its own, provided its new position be rigidly connected with the original position. It is also obvious, on the principle of the lever, that the efficiency of the couple depends on its moment simply, so that its arm may be shortened or lengthened at pleasure, provided the force be increased or diminished as the case may require, so as always to make the product of the force and arm the same. Suppose ropes fastened at the bow and stern of a ship pulling with equal force in opposite directions; they will make the ship turn round an axis through its center of gravity, at a rate depending on the force applied to the ropes. If the ropes be fastened to opposite points of the vessel nearer midships, it will only turn round at the *same* rate, provided the force applied to the ropes be *increased;* and, on experiment, it would be found that the force must be increased so that its product into the distance between the ropes shall equal the product of the force in the first case into the length of the ship. Through this we can compound couples acting in the same plane, for we can turn them round till their arms coincide, and then give them a common arm; their forces will then act in the same lines, when their resultant into the arm will be the new couple. So two couples which are situated in planes inclined at any angle to each other may be replaced by a single couple. Suppose the couples both to be moved in their respective planes till their arms coincide with the line of intersection of the planes, CD. Bring them then to a common arm in this line, AB. At



each end of this arm we shall have a pair of forces, say P and Q, inclined to one another at the angle of inclination of the planes. Their resultant, by the composition of forces, will be a force R, acting in a line between the planes. We shall have then forces R acting at each end of the arm, and evidently in directions parallel and opposite. R × arm AB, then, is the moment of the resultant couple. Having seen how to compound couples whose planes are inclined to one another, the theory of the composition of couples may be said to be complete; for if they are in parallel planes, we know we can bring them into the same plane and to a common arm, and so into a common couple. In statical theory, any number of forces acting on a body, and not in equilibrium, may be reduced to a single force, a single couple, or a single force and a single couple. We have shown that the couples may all be reduced to one, as well as those forces which do not produce couples. If the single force do not act perpendicularly to the plane of the couple, it can always be compounded with the forces of the couple, so as to reduce the whole to a single force; if it act perpendicularly, then it cannot be compounded with the couple, and the body will have at once a motion of translation and motion of rotation. See *Force* and *Rotation*.

COUPLING-STRAP.—A strap connected to the off bit-ring of the off horse, thence through the near bit-ring, and leading back to the harness of the near horse. Used with artillery-horses, and also for restive horses in ordinary service.

COUPURE.—A passage, about twelve or fifteen feet broad, cut through the glacis in the re-entering angle of the covered-way, to facilitate sallies by the besieged. They are sometimes made through the lower curtain to let boats into a little haven built in the re-entering of the counterscarp of the outworks.

COURCON.—A long piece of iron which is used in the artillery and which serves to constrain or tighten cannon.

COURIERS. — Government servants employed for carrying, securely and expeditiously, important dispatches. Active and accustomed to travel, speaking several languages, and with a sufficient idea of their own consequence, they will set out at a moment's notice, pursue their way by steamer, by rail, by hired voiture, or on horseback, with little intermission by night and by day, until they reach their destination. Acquainted with routes, officials, and methods of clearing the way, and provided with all proper credentials, including a requisite supply of cash, nothing interrupts them in their eager course.

COURONEMENT.—In fortification, this term signifies the most exterior part of a work when besieged. Sometimes written *Couronnement.*

COURTEL.—An ancient military implement which served both for a knife and a dagger.

COURT-MARTIAL.—A Court for the trial of any one belonging to the army or navy for some breach of military or naval law. The members of the Court fill the functions both of Judge and Jury. In the British army, Courts-Martial are *General*, *District*, or *Regimental*. The first is the only one of the three empowered to award death or transportation for life as a punishment to the offending person. It consists of thirteen Commissioned Officers, if so many can be obtained at the time and place; and a Deputy Judge Advocate is specially appointed to conduct the prosecution. A Non-commissioned Officer, or a Private, may be tried by any one of the three kinds of Court, but a Commissioned Officer only by a General Court-Martial. A *District* or *Garrison* Court-Martial may be convened by a Field-officer commanding a district or corps, without requiring the Sovereign's sign-manual. It consists of a number of members, varying from three to seven, with a Captain or higher officer to act as Deputy Judge Advocate. Such a Court tries Warrant Officers, Non-commissioned Officers, and Rank and File, and can only treat such offenses, or alleged offenses, as meet with secondary punishment. A *Regimental* Court-Martial may be convened by the Commanding Officer of a regiment or detachment; it consists of three or more members; it treats of minor offenses, and can award only minor punishments. In all these kinds of Court-Martial the members are sworn in; the Court is an open or public one; the vote or sentence is decided by majority, the junior members voting first; but two thirds of the whole number, in a General Court-Martial, are necessary to give validity to a sentence of death. Before execution, the sentence of every military Court-Martial has to be approved and confirmed by the Convening Authority. Sometimes *Courts of Inquiry* are held instead of a Court-Martial, not to try or to punish, but to make an investigation; the members not being on oath. Such a Court occasionally precedes a Court-Martial. In the United States the Court is composed of from five to thirteen Commissioned Officers of suitable rank. Regimental Courts-Martial, having jurisdiction of minor offenses, consist of not less than three Commissioned Officers; Garrison Courts-Martial are similarly constituted. A General Court-Martial for the army can be held only on the order of the President, or of the Commander of the Army, or an officer commanding a separate Department.

The following is the form of the order appointing a General Court-Martial, the last paragraph being omitted when the Court can be kept up with thirteen members:

HEADQUARTERS, ——, etc.

A General Court-Martial is appointed to meet at ——, on the —— day of ——, or as soon thereafter as practicable, for the trial of —— ——, and such other prisoners as may be brought before it.

DETAIL FOR THE COURT.

1. —— ——	8. —— ——
2. —— ——	9. —— ——
3. —— ——	10. —— ——
4. —— ——	11. —— ——
5. —— ——	12. —— ——
6. —— ——	13. —— ——
7. —— ——	—— —— *J. A.*

A greater number of officers than those named cannot be assembled without manifest injury to the service.

By order of ——— ———.

——— ———,
Assistant Adjutant General.

Under the provisions of the 74th Article of War, officers who may appoint a Court-Martial are competent to appoint a Judge Advocate for the same. Accordingly, a Judge Advocate must be appointed for a Regimental or a Garrison Court-Martial in like manner as for a General Court. The President of a Court-Martial, besides his duties and privileges as member, is the organ of the Court to keep order and conduct its business. He speaks and acts for the Court in each case where the rule has been prescribed by law, regulation, or its own resolution. In all their deliberations the law secures the equality of the members. The 86th Article of War does not confer on a Court-Martial the power to punish its own members. For disorderly conduct a member is liable as in other offenses against military discipline; improper words are to be taken down, and any disorderly conduct of a member reported to the Authority convening the Court. Application for delay or postponement of trial must, when practicable, be made to the Authority convening the Court. When made to the Court, it must be before plea, and will then, if in the opinion of the Court well founded, be referred to the Authority convening the Court, to decide whether the Court should be adjourned or dissolved, and the charges reserved for another Court. Upon application by the accused for postponement on the ground of the absence of a witness, it ought distinctly to appear on his oath—1st, that the witness is material, and how; 2d, that the accused has used due diligence to procure his attendance; and, 3d, that he has reasonable ground to believe, and does believe, that he will be able to procure such attendance within a reasonable time stated. Prisoners are tried on joint charges only for offenses necessarily involving concert of action. In all other cases the charges must be separate. Whenever the same Court-Martial tries more prisoners than one, and they are arraigned on separate and distinct charges, the Court is sworn at the commencement of each trial, and the proceedings in each case are made up separately.

The Judge Advocate summons the necessary witnesses for the trial; but he does not summon any witness at the expense of the United States, nor any officer of the army, without the order of the Court, unless satisfied that his testimony is material and necessary to the ends of justice. Officers or enlisted men who receive a summons to attend as witnesses before any Military Court, Board, or any Civil Court, or other Tribunal competent to issue subpœnas to witnesses, outside the limits of the Department where they may be serving, before starting to obey the summons, forward it through the proper channels to the Commanding General of the Department, that the necessary orders may be issued. Orders from competent military authority are required for the movements of all officers and enlisted men in such cases. In cases of extreme urgency, and when the public interest would be liable to suffer by delay, Post Commanders may authorize immediate departure in obedience to the summons. In such cases special reports are made of the facts and reasons to the Department Commander for his approval of the action taken. A Post Commander who may be summoned is governed by the foregoing. The Judge Advocates of Military Courts, in issuing process under section 1202, Revised Statutes, to compel the attendance as witnesses of persons not in the military service, formally direct the same to some officer designated by the Department Commander as available for the service. The nearest Military Commander will thereupon furnish the necessary military force for the execution of the process whenever such force shall be actually required. The preliminary summons or subpœna may be served upon a witness by any person whatsoever. Cases of habitual drunkenness and utter worthlessness, which have not already been made the occasion of a trial by Court-Martial, may be tried under the charge of "Conduct to the prejudice of good order and military discipline," with separate specifications for each one of the acts of drunkenness. Civil employés of the War Department serving with, or other persons properly attached to, an army in the field in time of war, may be understood as agreeing that they will submit themselves for the time being to military control. Accordingly, under the 63d Article of War, such persons are within military jurisdiction, as provided for in said article, when their treachery, defection, or insubordination might endanger or embarrass the army to which they belong in its operations against what is known in military phrase as "an enemy." To enable the officers of an army to preserve good order and discipline is the object of this paragraph, and these may be as necessary in the face of hostile savages as in front of any other enemy. When an army is engaged in offensive or defensive operations against a public enemy, it may be said to be "in the field." The fact that troops are operating in a region of country chiefly inhabited by hostile Indians, and remote from the exercise of civil authority, may enter into the description of "an army in the field." Under other circumstances, these civil employés do not belong to the military establishment in a sense making them amenable to trial by Court-Martial. The legal punishments for soldiers by sentence of Court-Martial, according to the offense and the jurisdiction of the Court, under the law, are: death; confinement; confinement on bread-and-water diet; solitary confinement; hard labor; ball and chain; forfeiture of pay and allowances; discharges from service, and reprimands; and, for Non-commissioned Officers, reduction to the ranks. The idea of punishment or degradation is not associated with the honorable and important duty of guards by imposing sentences of extra tours of guard-duty. Solitary confinement, or confinement on bread and water, cannot exceed fourteen days at a time, with intervals between the periods of such confinement not less than such periods, and not exceeding eighty-four days in any one year.

When the sentence of a Court-Martial is imprisonment, the Court indicates whether the prisoner shall be confined in a penitentiary or a military prison, according to law and the nature of the offense. When the Court has sentenced a prisoner to a *military prison* for any offense, no power is competent to increase the punishment by designating a *penitentiary* as the place of confinement. In order to keep men who are confined for purely military offenses apart from the moral influence of such as are convicted of penal offenses, it is desirable that Courts-Martial should designate confinement in a penitentiary instead of a military prison, when it can be done legally under the 97th Article of War. The sentence of a Court-Martial involving confinement for a definite period of time is considered as beginning from the date of the promulgation of the sentence in Orders, if the person sentenced is in custody at that time, unless the time of its commencement is otherwise expressly fixed by the sentence of the Court or in the Order promulgating the proceedings. When soldiers under sentence, or awaiting sentence, commit other offenses for which they are tried and sentenced, the second or cumulative sentence may be executed upon the expiration of the first, whether the Court or Reviewing Authority so specify or not. A sentence to confinement, with or without forfeiture of pay, cannot, in terms, be made to commence at a date prior to the confirmation of the proceedings of the Court. If it is proper to take into consideration the length of confinement to which the prisoner has been subjected previous to such confirmation, it may be done by the mitigation of the sentence, so that its term from the date of approval shall not extend beyond the period contemplated by the Court or by the Reviewing Officer When a sentence imposes forfeiture of the monthly pay, or of a stated portion of the monthly pay, for a certain number of months, the force of the sentence is to stop *for each month* the amount stated. Thus, *ten dollars of monthly pay for one year* would be a stoppage of one hundred and twenty dollars. When the sentence is silent as to the date of commencement of the forfeiture of pay, it begins with the date of promulgation of the sentence in Orders, and does not apply to pay accrued previous to that date. This holds good whether the sentence imposes a forfeiture of a specified sum or one of a certain amount per month. Where the same time is covered by two or more forfeitures, they must, as to such time, apply together, until all are satisfied. The rate of forfeiture for a given time will then be the aggregate of the rates of the several forfeitures applicable thereto, whether the actual rate of pay for the time be greater or less.

A Court-Martial cannot assign and make over the pay of a soldier to any other person, and the receipt of such person is not a sufficient voucher for the Disbursing Officer. Nor can a soldier be required to receipt for money paid without his consent to another person. The Authority which has designated the place of confinement, or Higher Authority, can change the place of confinement, except in case of prisoners confined in the Leavenworth Military Prison, who are subject only to the orders of the Secretary of War. Ordnance Sergeants, Commissary Sergeants, and Hospital Stewards, though liable to discharge, may not be reduced. Nor are they tried by Regimental or Garrison Courts-Martial, unless by special permission of the Department Commander. Every Court-Martial keeps a complete and accurate record of its proceedings, to be authenticated by the signatures of the President and Judge Advocate, who also certify, in like manner, the sentence pronounced by the Court in each case. The record must show that the Court was organized as the law requires; that the Court and Judge Advocate were duly sworn in the presence of the prisoner; that he was previously asked whether he had any objection to any member, and his answer thereto. A copy of the Order appointing the Court is entered on the record in each case. The record is clearly and legibly written, as far as practicable, without erasures or interlineations. The pages are numbered, with a margin of one inch on the left side of each page, and at the top of the odd and bottom of the even pages; through this last margin the sheets are stitched together; the documents accompanying the proceedings are noted and marked in such manner as to afford an easy reference. No recommendation is embraced in the body of the sentence. Those members only who concur in the recommendation sign it.

The record of the proceedings of a Court-Martial is indorsed on the first fold, by the Judge Advocate or Recorder of the Court, with the name of the place where the Court is held; the date when the proceedings were signed; the designation of Order convening the Court; the names of the Presiding Officer, the Judge Advocate, and of the Prisoner tried.

——— ——— ———,
——— —, 18—.
Proceedings of a General Court-Martial, convened by Special Orders No. —, dated Headquarters Department of ———, ——— —, 18—.

Colonel A—— B——,
—— Cavalry,
President.
Lieutenant C—— D——,
—— Infantry,
Judge Advocate.

CASE TRIED.
Private E—— F——,
—— Artillery.

The Judge Advocate transmits the proceedings without delay to the officer having authority to confirm the sentence, who states at the end of the proceedings in each case his decision and orders thereon.

When a Military Court adjourns for three days or more, the members belonging to the command where it assembles, or to adjacent posts (to which, with the sanction of the Department Commander, they return on the daily adjournments), will be liable to duty with their respective commands during the time of such adjournment, and the adjournment should be reported by the Judge Advocate or Recorder to the Commanders concerned. When the Court adjourns for less than three days, its members will ordinarily be exempt from other duty during that time. This paragraph is directory only, and may be modified by Department Commanders, according to the exigencies of the service. When a Court adjourns without day, the members return to their posts and duties unless otherwise ordered by the President or Competent Authority.

When General Courts-Martial try cases requiring the decision of the President of the United States, they should not be dissolved until his action is promulgated; but upon the completion of the trial the members should be ordered to resume their respective duties. When a Court-Martial appears to have erred in any respect, the Reviewing Authority may reconvene the Court for a reconsideration of its action, with suggestions for its guidance. The Court may thereupon, should it concur in the views submitted, proceed to remedy the errors pointed out, and may modify or completely change its findings. The object of reconvening the Court in such a case is to afford it an opportunity to reconsider the record, for the purpose of correcting or modifying any conclusions thereon, and, also, to make any amendments of the record necessary to perfect it. Anything like a reopening of the case, by calling new witnesses, or recalling those already examined, is wholly foreign to the proceeding. The power to pardon or mitigate the punishment ordered by a Court-Martial is vested in the Authority confirming the proceedings (except in case of prisoners confined in the Leavenworth Military Prison), and in the President of the United States. An abatement of five days upon each month of consecutive good conduct may be allowed to military prisoners upon each sentence to confinement for over six months. For the Leavenworth Military Prison the orders are issued by the Commander of the Military Department of the Missouri. All other orders for pardon, mitigation, or discharge of prisoners confined in the Leavenworth Military Prison must emanate from the War Department. An order remitting forfeiture of pay operates only as to time subsequent to its date. The forfeiture continues operative for the time between date of promulgation of sentence and date of order of remission, and at the rate fixed in the sentence if the forfeiture be one of a certain amount per month; or, if it be of a specified sum, at the rate of the soldier's current pay, less deduction for Soldiers' Home. To this extent a remitted forfeiture must stand as a charge against the soldier's pay until satisfied. In case of a sentence contemplating payment of a stated sum to a soldier upon his release from confinement, such payment is made only when there is sufficient balance to his credit after deducting all authorized stoppages.

Company Commanders should be careful in noting sentences upon muster-rolls to give all of the data affecting pay, including the dates of the several orders of sentence and remission. Where one or more payments have been made to the soldier for time subsequent to date of an order of sentence, the muster-roll should be made to show the amount that has been deducted on account of the forfeiture. The data required by this regulation should continue to be borne on successive muster-rolls until the entire amount of the forfeiture for the time between dates of orders of sentence and remission shall have been deducted.

Whenever prisoners are sent to the Leavenworth Military Prison to serve out their sentences, the order promulgating the sentence, and the descriptive list (to which will be appended a statement of conduct), are forwarded with them.

The employment of a Reporter, under section 1203, Revised Statutes, is only authorized for General Courts-Martial in cases where the Authority convening the Court may consider such an officer necessary. When Reporters are employed, they are allowed not to exceed ten dollars a day, to cover the whole period of absence from their residence, traveling, or on duty. If the place of meeting of the Court be changed, transportation in kind is allowed. They are paid by the Pay Department on the usual certificate of the Judge Advocate.

Under the Rules and Articles of War, it is made the duty of Commanding Officers to see reparation made to the party or parties injured, from the pay of soldiers who are guilty of abuses or disorders committed against citizens. Upon proper representation by any citizen of wanton injury to his person or property, accompanied by satisfactory proof, the Commanding Officer of the troops causes the damage to be assessed by a Board of Officers, the amounts stopped against the pay of the offenders, and reparation made to the injured party. This proceeding is independent of any trial or sentence by Court-Martial for the criminal offense. See *Field-officer's Court, Garrison Court-Martial, General Court-Martial*, and *Regimental Court-Martial*.

COURT OF CHIVALRY.—A Military Court established by Edward III., of which the Earl Marshal and the Lord High Constable were joint Judges. When held before the Earl Marshal alone it was merely a Court of Honor; but when both were present it was also a Criminal Court. Having encroached on the common law, its jurisdiction was defined by an Act under which the Court claimed power to give relief to such of the nobility and gentry as thought themselves aggrieved in matters of honor, and to keep up the distinctions of degrees and quality. In criminal cases a jury was sworn; but in general the proceedings of the Court were summary matters, being brought under its cognizance by complaint or petition. An attempt was made to revive the functions of the Court in Queen Anne's time; but, except as represented by the Earl Marshal's Court (see *College of Arms*), it has now gone into abeyance.

COURT OF HONOR.—A Military Court authorized by the regulations of the Prussian service, convened for the purpose of sustaining the honor of the service and of individuals, and of punishing officers who may be found guilty of conduct deviating even in the least from the principles which actuate military men as men of honor. The Court of Honor of a regiment consists of all Commissioned Officers in it except the prosecutor, the defendant, near relations, officers appearing as witnesses in the case, officers on leave, detached service, under arrest, or awaiting trial before any Court; and has for its regular business management a Council of Honor, consisting of the Senior Captain, Senior First Lieutenant, and Senior Second Lieutenant. The Court has jurisdiction over all acts or omissions (not provided for by any fixed laws) which are unofficer-like or ungentlemanly in their nature, particularly such as contracting debts, improper choice of society, excessive use of intoxicating liquors, gambling, quarrels, carelessness or neglect of duty, and scandal. With the exception of General Officers, all officers of the Standing Army, the Reserve, the Landwehr, and those of the Retired List are subject to the laws of the Court of Honor. The Court to investigate the conduct of a Field-officer is made up of the Field-officers of the division to which the officer belongs.

COURT OF INQUIRY.—In cases where the General or Commanding Officer may order a Court of Inquiry to examine into the nature of any transaction, accusation, or imputation against any officer or soldier, the said Court shall consist of one or more officers, not exceeding three, and a Judge Advocate, or other suitable person as a Recorder, to reduce the proceedings and evidence to writing, all of whom shall be sworn to the faithful performance of duty. This Court shall have the same power to summon witnesses as a Court-Martial, and to examine them on oath. But they shall not give their opinion on the merits of the case excepting they shall be thereto specially required. The parties accused shall also be permitted to cross-examine and interrogate the witnesses so as to investigate fully the circumstances in the question. The proceedings of a Court of Inquiry must be authenticated by the signature of the Recorder and the President, and delivered to the Commanding Officer, and the said proceedings may be admitted as evidence by a Court-Martial, in cases not capital or extending to the dismission of an officer, provided that the circumstances are such that oral testimony cannot be obtained. But Courts of Inquiry are prohibited unless directed by the President of the United States or demanded by the accused. The Court may be ordered to report the *facts* of the case with or without an opinion thereon. Such an order will not be complied with by merely reporting the evidence or testimony; facts being the result, or conclusion established by weighing all the testimony, oral and documentary, before the Court.

When a Court of Inquiry is directed to be assembled, the order should state whether the Court is to report the facts or not, and also whether or not it is to give an opinion on the merits. The Court should also be instructed whether its attention is to be extended to a general investigation, or to be confined to the examination of particular points only, as the case may seem to require, in the judgment of the officer under whose authority it is assembled. Where the subject is multifarious, the Court should be instructed to state its opinion on each point separately, that the proper authority may be able to form his judgment.

The Court may sit with open or closed doors, according to the nature of the transaction to be investigated. The Court generally sits with open doors; but there may be delicate matters to be examined into that might render it proper to sit with doors closed. The form of proceeding in Courts of Inquiry is nearly the same as that in Courts-Martial: the members being assembled, and the parties interested called into Court, the Judge Advocate or Recorder, by direction of the President, reads the order by which the Court is constituted, and then administers to the members the following oath: "You shall well and truly examine and inquire, according to your evidence, into the matter now before you, without partiality, favor, affection, prejudice, or hope of reward: so help you God." The accusation is then read, and the witnesses are examined by the Court; and the parties accused are also permitted to cross-examine and interrogate the witnesses so as to investigate fully the circumstances in question. The examination of witnesses being finished, the parties before the Court may address the Court should they see fit to do so; after which the President orders the Court to be cleared. The Recorder then reads over the whole of the proceedings, as well for the purpose of correcting the record as for aiding the memory of the members of the Court. After mature deliberation on the evidence adduced, they proceed to find a state of facts, if so directed by the order constituting the Court, and to declare whether or not the grounds of accusation are sufficient to bring the matter before a General Court-Martial; and also to give their opinion of the merits of the case if so required. The Court should be careful to examine the order by which it is constituted, and be particular in conforming to the directions contained therein, either by giving a general opinion on the whole matter, a statement of facts only, or an opinion on such facts. The proceedings of Courts of Inquiry have been returned to be reconsidered when the Court has been unmindful of these points. It has been settled that a member of a Court of Inquiry may be objected to for cause. The proceedings must be authenticated by the signatures of the President and Recorder, and delivered to the Commanding Officer or Authority which ordered the Court; and the said proceedings may be admitted in evidence by a Court-Martial, in cases not capital nor extending to the dismission of an officer, provided oral testimony cannot be obtained. Transactions may become the subject of investigation by Courts of Inquiry after the lapse of any number of years, on the application of the party accused or by order of the President of the United States; the limitation mentioned in the Articles of War being applicable only to General Courts-Martial. It is not necessary to publish the proceedings or opinion of the Court, although it is usually done in General Orders. The Court is dissolved by the Authority that ordered it to convene.

COUSSINET A MOUSQUETAIRE.—A bag formerly worn by a French soldier on his left side beneath the cross-belt. It hung on a hook near the butt of his musket. The expression likewise signifies a wedge used to support the mortar in its frame.

COUSTIL A CROC.—A short sword of Italian origin used in the fifteenth century, and very much like the *anelace*.

COUTERE.—An ancient piece of armor which covered the elbow. At present but little used.

COUVRE-BASSINET.—A plate that moves on a hinge and covers the priming after it has been placed above the pan or bassinet.

COVER.—1. Natural or artificial protection from the fire of the enemy, the former being afforded by hills, woods, banks, walls, etc., the latter by fortifications constructed for the purpose. 2. To stand exactly in front or in rear of another man or object.

COVERED COMMUNICATIONS.— Shelter-trenches are much used to afford covered communications along a given front; to connect the works in a "line with intervals;" to bring a musketry-fire upon ground which cannot be swept by the fire from a particular work, etc. A trench, when used as a communication for infantry only, should be made three feet deep, and four feet wide at the bottom. The earth should be thrown on the side towards the enemy, and then leveled off in the form of the superior slope of a parapet, so that the men in the trench can fire over this mass of earth. If the trench is to be used for the passage of artillery, or to be used by bodies of troops passing from one point to another along the front, the least width at bottom should be made eight feet, and the height of the top of the mound of earth should be at least six feet and a half above the bottom of the trench. The side of the trench toward the enemy should be cut into offsets, and arranged so as to allow a fire of musketry over the parapet. Shelter-trenches are rarely made to follow a straight line, but usually conform to the contour of the ground. The trace should be marked on the ground if there is time to do it. It will economize the labor of the troops, and avoid an unnecessary waste of time. The trace should be governed by the general rules laid down for field-works, and great care should be taken that it cannot be enfiladed by a fire of the enemy. Profiles are not necessary. The points which would be occupied by them may be marked by men standing upon the edge of the proposed trench towards the enemy. A line would then be marked on the ground, by a pick, passing through the points selected. Parallel to this line, and twelve or fifteen feet in rear of it, the line of troops should be formed The front rank, furnished with intrenching-tools, would begin the digging; the rear rank would lie down. Reliefs should be formed, and the trench rapidly executed. The shelters for artillery or cavalry may be made in a very short time, in a way similar to that shown for the shelter-trench for infantry. On undulating ground the shelter-trench for infantry is frequently on the slope; the shelter for artillery would generally be on or behind the crest. A piece of artillery on the crest of undulating ground can be quickly run under cover, if it be desirable. This cover can be quickly and easily improved, by making a slight excavation and arranging a mass of earth in front of the gun. Slopes of this kind could be used for infantry as well as for artillery; and where a simple screen is the main object to be had, the communication would be along the reverse slope. See *Communications*.

COVERED DEFENSES.—To this class belong those constructions and arrangements intended to shelter the troops and *matériel* from vertical fire. Scarp and counterscarp galleries, casemates, casemated caponieres, bomb-proof barracks, etc., are examples. In the permanent works of more recent construction in our own country and in Europe, revetment-walls with relieving arches have in most cases been introduced instead of the ordinary thick walls with counterforts, which had been hitherto the usual mode of retaining the earth of the rampart and parapet. The piers of the relieving arches, which also serve as counterforts to the revetment-wall, are rectangular in plan, and usually run back from 12 to 16 feet. They are from 4 to 6 feet thick, and placed from 12 to 18 feet apart between their center lines. The arches are usually full center and two feet thick, with a rough shaped capping which adds an additional thickness from 9 to 12 inches over the crown of the arch. When the scarp-walls are entirely detached, leaving an open corridor between them and the rampart, they are pierced with one or two tiers of loop-holes, from which a fire can be brought upon the ditch and upon the terre-plein of the covered-way, or any work in front of the enceinte. To give cover to the men at the loop-holes, arched recesses are made in the thickness of wall, or else short counterforts are built back from the wall, which serve as the piers of covering arches. The width of the recesses should admit of three or four loop-holes at the usual distance apart, their height and depth being sufficient to give the men shelter from vertical fire and allow them to handle their arms with convenience. The most simple method of arranging a gallery behind a counterscarp-wall for the defense of a ditch is to build another wall parallel to that of the counterscarp, and to throw an arch over between the two to cover the top of the gallery. The counterscarp-wall is pierced with loop-holes arranged in the same way as in scarp-galleries.

Caponiere defenses for the ditches are classed under the head of what are termed *defensive casemates*, which are bomb-proof arched structures for receiving cannon, firing through embrasures pierced in the front or mask wall of the casemates. Defenses of this class, when used to flank the ditch, are termed *casemated caponieres*. These defenses are usually placed in the ditch at the middle point of the side or front to be flanked. The outline of their plan is mostly that of a lunette, the flanks being perpendicular to the line of the scarp, and the two faces making a salient angle of 60 . The caponiere is either built in juxtaposition with the enceinte, or else detached from it. In the latter case an inclosure is formed between the two by a loop-holed wall which connects the flanks with the scarp-wall. Each flank consists of one or two tiers of arched chambers, the piers of the arches being perpendicular to the back of the walls of the flank. Each chamber is of sufficient dimensions for the service of a single gun with a contracted field of fire. In some cases loop-holes are pierced for small-arms on each side of the embrasure; in others the casemates of one story are pierced for cannon, and the other for small-arms. The casemates are closed in rear by a thin wall, which is provided with windows for light and ventilation; and the piers are pierced with doorways to form a communication between the chambers and to assist the ventilation. Flues or vents are made in the front wall, just under the arches, for a like purpose. Where it may be necessary, the lower floor is drained by a conduit through the front wall.

It should be observed that whatever advantages covered defenses afford as shelter from the assailant's fire, they present the inconveniences of a comparatively narrow and obstructed field of view to the assailed, which is further obscured by the smoke which may gather within the gallery, and in front of the loop-holes. From these causes the assailed having to aim at a venture, his fire is likely to be less effective than in open defenses, where the smoke disperses rapidly and leaves a clear field of view. The same may be said of loop-holed walls covering exterior corridors where the space to the rear is confined. Owing to these considerations, loop-holed and covered defenses of the kind in question should be restricted to special defensive purposes, where an object within the field of fire can be attained with some certainty whether seen or not by the assailed; as, for example, the protection of a ditch, or a scarp-wall which cannot be flanked from within the work; for sweeping a covered-way, or the interior of any outwork which cannot be brought well under the fire of the parapet of the main work. As the main object of covered defenses is protection against shells, it is essential that the arches of the galleries should be bomb-proof. As the span of these arches is usually small, a thickness of 2 feet given to the masonry, and a covering from 4 to 6 feet of earth above it, are ordinarily considered sufficient for the object in view. With regard to the front walls of these constructions, as they are too thin to withstand the direct action of artillery, they must either be covered by earthen masks, as a glacis raised beyond the counterscarp, for example, or be used only in positions where they are not exposed to this fire. See *Casemates*.

COVERED FLANK.—The platform of the casemate, which lies hid in the bastion. These retired flanks are a great defense to the opposite bastion and passage of the ditch, because the besiegers can neither see nor easily dismount their guns.

COVERED-WAY—COVERT-WAY.—In fortification, an open corridor or passage bordering the ditches of the enceinte and outworks, if there be any, forming a continuous line of communication around the fortification, masked from the view of the enemy by an embankment of sufficient height to cover the troops in it. The covering embankment is arranged towards the covered-way like an ordinary parapet, and receives on the exterior a gentle slope or *glacis*. This outwork is indispensable to a garrison determined on an active and vigorous defense. By means of it the garrison have a covered position beyond the ditch where they can assemble with safety, either for the purpose of making a sortie, or to guard the ditches and the communications across them; and it affords them also a secure point of retreat if repulsed in a sortie, as a reserve left in the covered-way will be at hand to check the pursuit by their fire, and enable the retreating party to gain the enceinte. The covered-way prevents all access to the ditch by a strong fire of musketry, which sweeps all the exterior ground, and affords facilities for posting beyond the ditch sentinels and small detachments to guard the ditches and the communications across them. It is the most indispensable of all the outworks, and it is only in rare cases that we can do without it. Vauban placed a high value on this work, which, to use his own words, "costs less to the defense and more to the assault than any other work." See *Outworks*.

COVERING FASCINES.—Fascines made of stout picket stuff, not less than one inch thick, without any mixture of small brushwood. They may be used in place of planks for the superstructure of wooden bridges; and may also be used, if no stout planks or spars are to be had, for the roofs of field powder-magazines. They may be made of the usual diameter of nine inches. Their length will depend upon the particular purpose for which they are intended

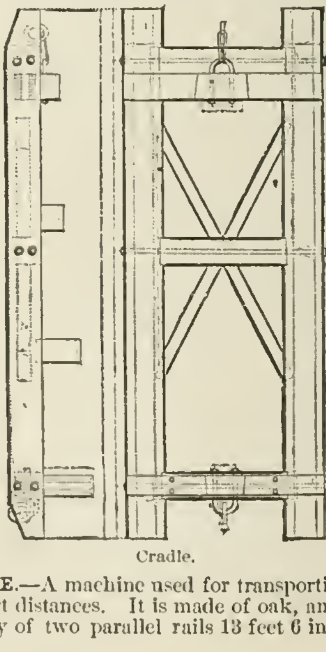
COVINARII.—The soldiers who fought on the *covinus*, a kind of war-chariot used by the ancient Britons and Belgians.

COWARDICE.—Want of courage to face danger. The Articles of War declare that any officer or soldier who misbehaves himself before the enemy, runs away, or shamefully abandons any fort, post, or guard, which he is commanded to defend, or speaks words inducing others to do the like, or casts away his arms or ammunition, or quits his post or colors to plunder or pillage, shall suffer death, or such other punishment as a Court-Martial may direct.

COW-BOYS.—A band of marauders in the time of the American Revolution, consisting mostly of refugees who adhered to the British side, and who infested the so-called *neutral ground* lying between the American and British lines, plundering all those who had taken the Oath of Allegiance to the Continental Congress. The term has recently been applied to marauding parties in the Western States and Territories.

CRAB.—A winch on a movable frame with power-gearing, used in connection with derricks and other non-permanent hoisting-machines. The larger gear-wheel is on the shaft of the roller, and is rotated by the spur-pinion and hand-cranks. The crab or geared capstan used in mechanical maneuvers consists of a strong frame of oak timber firmly fastened to the ground by stakes, or tied by rings in the ends of the side pieces. The bottom side pieces are joined by two cross-braces, between the tenons of which, and through from end to end of each, passes a bolt, firmly fastening the frames together. The bottom and top side pieces are joined by four upright and eight inclined braces. A bolt passes through the upright braces from top to bottom, binding the parts together. Extending across the frame are two shafts, which rest in cast-iron boxes fastened to the top pieces. Upon one is fastened a cast-iron drum and a large geared wheel, having 110 teeth; on the other a small geared wheel with 14 teeth and the cranks for turning, which are held in place by nuts. This axle has a motion in the direction of its length to disengage the geared wheels when desired. See *Mechanical Maneuvers*.

CRACKED HEELS.—From careless grooming, washing horses' legs and imperfectly drying them, permitting them to stand in accumulations of filth or exposed to draughts, the skin becomes inflamed, tender, itchy, thickened, and by and by cracked. An ichorous noisome discharge exudes, and lameness often results. In animals with round, *gummy* legs it is sometimes constitutional; underbred horses with rough hairy fetlocks present the majority of cases; white heels, being more delicate, are especially affected; whilst the hind limbs, exposed as they are to filth and cold, suffer most frequently.



Cradle.

CRADLE.—A machine used for transporting heavy guns short distances. It is made of oak, and consists essentially of two parallel rails 13 feet 6 inches long and 10 by 12 inches thick. These rails are united by a transom near each end and one in the middle; these transoms have such length as to make the entire width of the cradle 60 inches. A bolster is placed over each end-transom; the ends of these bolsters are flush with the exterior sides of the rails. The bolsters for the support of the breech are 6 inches high and 8 inches thick; that for the chase, 15 inches high and 6 inches thick; the middle part of the top of each is slightly hollowed out to form seats for the piece. A movable bolster, having notches at each end to fit upon the rails, is intended to be placed tight up against the middle part of the gun after it has been placed on the cradle. Diagonal braces are fitted inside between the rails and transoms. The under part of the ends of the rails, both front and rear, is beveled off, so that, in moving in either direction, the rollers can be caught under the cradle with facility. The under surfaces of the rails are shod with iron to prevent them from splintering out. A ring is attached by a link and eye-bolt to each end-transom for the purpose of attaching blocks and tackle when moving the cradle and piece. The cradle moves on wooden rollers; each roller is 78 inches long and 7 inches in diameter. From six to ten rollers are required; they rest and move on way-planks laid on the ground. See *Mechanical Maneuvers.*

CRAKERS.—A term applied to the choice soldiers of various organizations in the time of Henry VIII.

CRAKYS.—An ancient term commonly applied to great guns. It is now quite obsolete.

CRAMPETS.—A term very frequently applied to the cramp-rings of a sword-scabbard.

CRAMPTON ROTARY PUDDLING - FURNACE.—This furnace, used in the Royal Gun Factory, is designed to accomplish the following points: (*a*) The utilization of slack or small coal without the production of smoke; (*b*) the automatic feeding of fuel and air in proper proportions, by which only perfect combustion can be effected; (*c*) the production of heat of the highest intensities with perfect regularity both as regard intensity and quality; (*d*) the construction of puddling-furnaces without brick-work, composed of a single chamber, in which the gas is produced, consumed, and the material treated; (*e*) the reduction of wear and tear both of the lining and of the furnace by the prevention of unequal contraction and expansion; (*f*) also to effect the fettling of the revolving furnace in a quick, simple, and effective manner; (*g*) and, lastly, to eliminate phosphorus and sulphur from common pig to such an extent as to enable good steel to be produced from it.

This puddling-furnace consists of a cylindrical casing of wrought-iron, the casing being made double, so that a water-space is formed both at the sides and at the ends. To the center of one end is attached a two-way cock, which communicates with two pipes. Through one pipe the incoming water is conducted direct to the front of the furnace, while through the other heated water escapes at a temperature of 90 degrees. The main body of the furnace is hooped at two points by steel tires, these tires each taking a bearing upon a pair of carrying-wheels. These carrying-wheels or rollers turn on bearings supported by plummer-blocks fixed to the large cast-iron base-plate which carries the whole furnace. The turning-gear of the furnace is very simple, and consists of a pinion engaging a toothed segment bolted to the casing, and worked by a small engine with diagonal cylinders. The supply of the powdered fuel is arranged by means of a revolving worm or creeper, which carries the dust along the duct, where it is deposited in front of the extremity of an air-pipe leading from the fan, the blast from which delivers the coal-dust into the furnace and assists in its combustion. It may be here stated that at the time the trial of this furnace was proposed coal was at an enormous price, and any economy of fuel was of the highest importance. The results of experiments with this furnace showed that the iron produced from it was defective in the following important qualifications: 1. It could not be often reheated; 2. It was not free from blister; 3. It was often red-short. These defects render it unsuitable for the manufacture of ordnance. See *Furnace* and *Iron*.

CRANE-DREDGE.—A variety of dredging-machine formerly used, but now, in a great measure, superseded by the boom-dredge. The crane-dredge, as commonly built, is provided with a set of three-threaded blocks, for multiplying the hoisting-power; but since these augment the prejudicial resistance of friction, and increase the time of hoisting and discharging the filled dipper, we have assumed the drum-strain to be transmitted directly to the dipper-bail. This is fair for comparative purposes, since it reduces both dredges to the same relative conditions—the new dredge being generally worked with a single chain, although the threaded blocks might be applied to it if deemed expedient. It is apparent that at commencement of work the greater the angle included between the hoisting or excavating chain and the dipper-handles, the greater will be the force in the direction of the bank, and the smaller in the line of the dipper-handle. Experiments have been conducted with a view to making this angle as large as possible without impairing the efficiency of action, and the first step in this direction was the invention of the "extension-crane," which remedied the matter a trifle; then followed the arm pivoted to the long side of the crane, and bearing, at its outer end, sheaves, over which the hoisting-chain was worked. This invention, while fulfilling its mission, was yet so annoying in its action that it was abandoned.

In the common form of the crane-dredge, the angle included between the excavating-chain and the dipper-handles is about 8°. After much study and extensive experiments, Mr. Ralph R. Osgood invented his boom-dredge, in which the angle in question is almost 30 . Since the component of force in the direction of the bank is almost directly proportional to the size of this angle, the boom-dredge will have a bank force nearly 3.5 times as great as given by the crane-dredge. The boom-dredge, by dispensing with fall-blocks, is enabled to raise its load quicker, and with less loss of power by friction, than the crane-dredge; and also requires a shorter dipper-handle, from the fact that its uppermost point of support — the friction-clutch or brake—is brought, by means of the falling or movable boom, 10 feet or more nearer the dipper. It is also strained less, thus requiring less material for its construction and being less liable to bend or break. See *Boom-dredge*, *Dredging-machine*, and *Excavator*.

CRANES.—Cranes are employed for moving ordnance, molds, and other heavy masses about a foundry. They are fitted with cog-wheel gearing to obtain power at the expense of time, and are often worked by steam. Care must be taken to give great strength to this machine, and to cause its motion to be easy on its pivot. When properly adjusted a weight may be lifted and transported from one point to another, anywhere within the limits of the circle described by the arm.

Cranes are most clearly classified by reference to their modes of transferring their loads horizontally; and, thus considered, are found to divide themselves into the following groups, viz.: 1. *Rotary*—In which the load is revolved around a fixed center, such as a mast or column. 2. *Rectilinear*—In which the load is moved in straight lines, in one or more directions. Both types of cranes are subdivided into two general classes as to their movements, viz.: (*A*) *Fixed*—When their supporting members are fixed in some permanent location. (*B*) *Movable*—When the crane as a whole can be moved about. And into four other general classes as to their source of motive power, viz.: (*a*) *Hand*—When the motions, either vertical or horizontal, are effected by manual power. (*b*) *Power*—When the motions are effected by power derived from line shafting driven by a stationary engine or other fixed motor. (*c*) *Steam*—When the motive power is derived from a steam-engine attached directly to the crane itself and moving with it. (*d*) *Hydraulic*—When the motive power consists of hydraulic pressure obtained from a pump or accumulator, and carried to the crane by pipes.

A further distinction is covered by the term *locomotive*, which is applied to cranes (usually of the rotary type) which are capable of propelling themselves upon a roadway or track. Rotary cranes comprise the following principal types, viz.: 1. *Swing-cranes*—In which the central mast is pivoted to the floor and roof of the building, and the load is suspended from a block fixed at the outer end of an arm projecting horizontally from the mast, the only horizontal motion being one of rotation. 2. *Jib-cranes*—In which the central mast is pivoted to the floor and roof of the building, and the load is suspended from a trolley traveling in and out upon an arm or jib projecting laterally from the mast. 3. *Column-cranes*—Which consist of a jib-crane constructed to revolve around or upon a fixed column forming the support of a building or floor. 4. *Pillar-cranes*—In which the central column or pillar is entirely supported by a heavy foundation built at its base, and the load is suspended from a boom projecting from the pillar and revolving with it or around it. 5. *Derrick-cranes*—Which consist of a jib-crane for yard use, the upper end or pivot of the mast being held in position by guy-rods or stays, instead of by attachment to a roof or ceiling. 6. *Walking-cranes*—Which consist of a pillar- or jib-crane mounted on wheels, and arranged to travel by power or by hand upon one or more rails. 7. *Locomotive-cranes*—Which consist of a pillar-crane mounted on wheels, and provided with a steam-engine and boiler, the power of which is available for operating the crane and for propelling it upon its tracks.

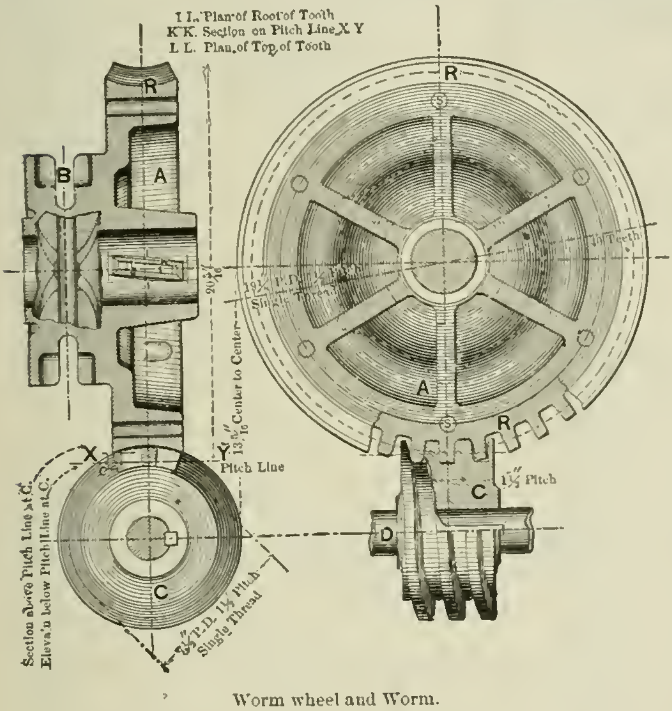
Rectilinear Cranes comprise the following principal types, viz.: 1. *Bridge-cranes*—In which a fixed bridge spans an opening, and the load is suspended from a truck or trolley capable of moving across the bridge. 2. *Tram-cranes*—In which a truck or short bridge, from which the load is suspended, is arranged to travel longitudinally upon a pair of overhead-rails, but is without capacity for transverse motion. 3. *Traveling-cranes*—In which a rectangular space is provided with overhead-tracks upon two of its opposite sides, and is spanned by a bridge arranged to travel longitudinally upon these tracks, the load being suspended from a truck or trolley capable of moving transversely across the bridge, so that the load may be moved to or from any point within the entire rectangle. 4. *Gantries*—In which an overhead-bridge is supported at each end by a frame, or trestle, extending downwards, and having wheels in its base to permit of travel upon two longitudinal tracks laid upon the ground, so that the entire structure can move endwise upon the latter, and the load, which is suspended from a truck or trolley on the bridge, can be moved transversely across the bridge. 5. *Rotary Bridge-cranes*—Which combine a rotary with a rectilinear movement, and consist of a bridge having one end pivoted to a central pier or post, while the other or outer end travels on a circular overhead-track, or is supported by a gantry-frame traveling upon a circular track upon the ground, the load being suspended from a truck or trolley traveling transversely across the bridge.

The most important factor in the economy and convenience of a crane is the mechanism by which the load is lifted and lowered, as it must necessarily come into action every time the crane is used. In all applications of power, from whatever source derived, it must be remembered that the gearing of a machine can only modify the power applied in one of two ways, viz.: (1) By reducing its velocity, and proportionately increasing its force or "pull." (2) By increasing the velocity, and proportionately decreasing the intensity of the power transmitted. Under no circumstances, unless the motive force is increased, can power be gained except by a sacrifice in speed, or can speed be increased except by a sacrifice in power. If either or both must be increased without diminishing the other, it can only be accomplished by supplying more motive power. The function of gearing, then, is to change the force or direction of the power applied. If it is well designed and constructed, this may be done with only a small loss from friction; while if badly made, the gearing may absorb much power in wasteful friction of its moving parts. In machinery for hoisting, the "purchase," or conversion of velocity into lifting power, is usually effected partly by a multiplication of the ropes or chains of the tackle through which the load is suspended, and partly by gearing within the machine, which latter thus becomes an important feature in crane-work. The gearing ordinarily used for this purpose consists either of spur-wheels and pinions or of worm-wheels and worms, or both combined, and the smoothness and economy of power of the machine depend largely upon the manner in which the gearing is made.

A second feature of prime importance in the hoisting-gear of a crane is the mode of sustaining the load, and guarding against its "running down" when the application of the motive power is discontinued. This has heretofore been accomplished, in machines having spur-gearing, by a ratchet-wheel, the pawl of which has to be entirely disengaged to permit lowering to occur, or by a brake, which, when on, prevents all motion of the machine, and which requires to be held or thrown off, both in hoisting and lowering. In machines having worm-gearing the end is attained by a construction of the worm-wheels such that the friction between the worm and the wheel is sufficient to prevent the backward rotation of the worm under the pressure of the teeth of the worm-wheel caused by the load, the resistance thus generated sufficing to prevent the running down of the load. There is a current opinion among machinists in general that worm-gearing offers so disastrous a frictional resistance in wear, that its use, except for purposes where little power is to be transmitted, and where certain slow movements are to be effected, is not permissible in good mechanism. This view is supported by most of the text-books, which invariably represent the laying out of the teeth by considering the worm as a rack with inclined teeth where the pitch-lines of the worm and wheel are taken on a plane passing through the axis of the worm. Now, the fact is that the use of worm-gearing for hoists, cranes, boring-bars, lathes, etc., has been growing in favor and it is found that neither excessive loss of power nor excessive wear of gearing ensues. In regard to friction, it is established that for the ordinary ratio of wheel to worm, say not to exceed 60 or 80 to 1, well fitted worm-gear will transmit motion backward through the worm, exhibiting a lower coefficient of friction than is found in any other description of running machinery.

In order to reach this result the following method of laying out a worm-gear and worm is employed. Assume the teeth on the worm to be .65 of the pitch radially, of which .60P is to be the line of contact with the teeth of the wheel (on the radius and also on the plane through the middle of the teeth), and that .05P be for clearances between the roots and points of worm and wheel teeth. Let the teeth of the wheel follow the circle of the worm throughout the arc, which ought not to exceed 60°. Let R = outside radius of worm; Rp = radius of pitch of worm; F = face of wheel at root of teeth; and P = pitch of teeth: then $Rp = \frac{1}{2}\{R + (R - .6P)\cos a\}$, and $F = 2(R + .05\,P)\sin a$. To simplify the process of laying out worm-wheels, it has been usual to make the outside radius of the worm $R = 2P$, and the angle $a = 60°$, when $Rp = 1.606P$, and $F = 2.05P$. The effect of this method of setting out pitch-lines for the teeth of screw-gearing is to bring the bearing, or working lines of contact, for both orders of teeth more nearly on the true pitch-line, and not to throw much effort or work on the points of the teeth of the worm-wheel outside of the true pitch-line. The following illustration represents a worm-wheel and worm constructed in accordance with the above system, and of the proportions employed in the Weston cranes.

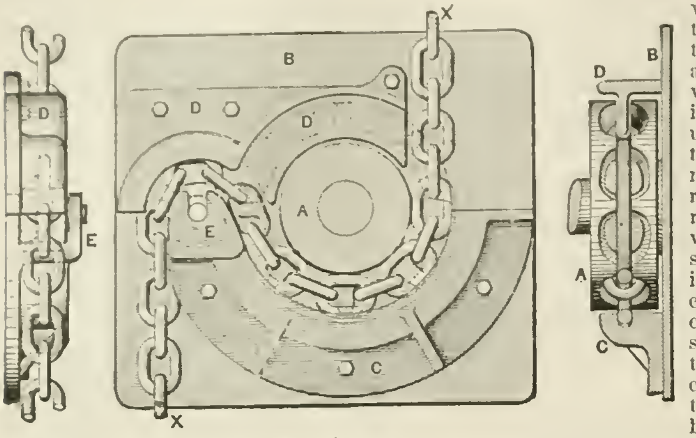
In all cranes, except those of small size, provision should be made for one or more changes of speed in hoisting and lowering, so that the speed may be varied according to the load and the nature of the work to be done. Cranes operated by power *may* be so constructed that the maximum load can be lifted at the quickest speed; but they are usually so proportioned that this can be done only at a slow speed. By this plan much economy of gearing, space, and cost is effected, and the practical efficiency of the crane for all ordinary uses is not impaired. The most perfect construction is one that permits a change of speeds to be made whether the hoisting-gear is in motion or at rest, and which sustains the load automatically while a change of speed is being made. The hoisting-gear of a crane should therefore attain the following results, viz.: (1) Such changes in direction and velocity



Worm wheel and Worm.

of the power applied as will give the desired motions to the load. (2) The accomplishment of this with a minimum loss of power through friction. (3) The safety, both of the operator and the load, under all conditions; to insure which the load must be always self-sustained and incapable of "running down." (4) Capacity for changes of speed and for convenient transition from one of these to another at will, whether the gearing is in motion or at rest, and for the automatic support of the load during the act of changing speeds.

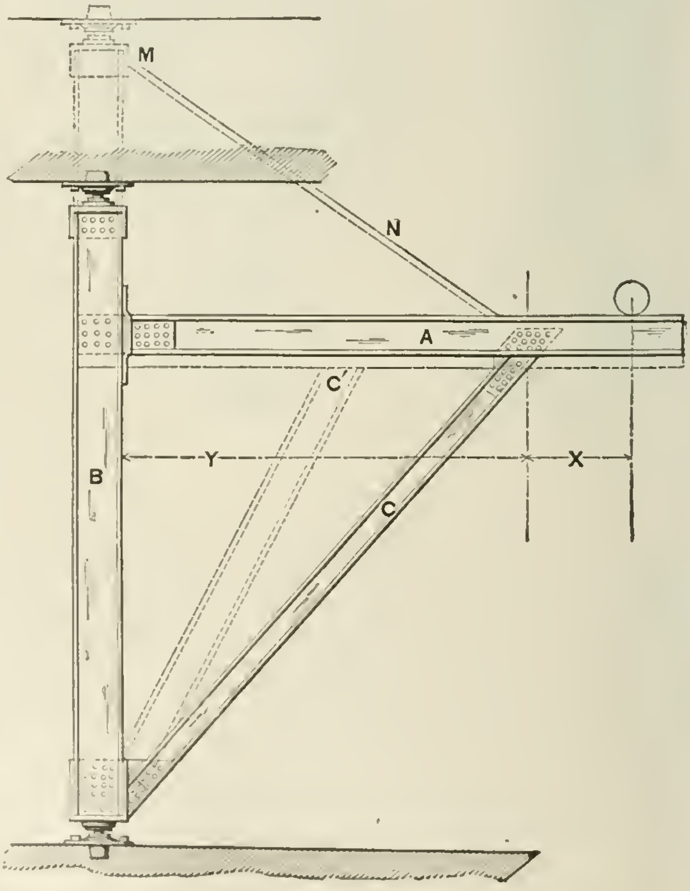
In some types of rotary cranes no traverse mechanism exists, except an arrangement of parts which provides for the rotation of the crane. In others, such as jib- and derrick-cranes, provision must also be made for moving the truck or trolley horizontally on the jib, and the same provision is required for moving the trolley of bridge- and traveling-cranes transversely on the bridge. In all such cases a separate mechanism, distinct from the hoisting-gear, has heretofore been employed, and is still sometimes desirable or convenient. When employed, its parts should be as few and simple as possible, and it should be so far independent of the hoisting-gear as to permit either to be used at any time separately or conjointly. In power-cranes provision should be made for accelerating the speed of the trolley-travel whenever the nature of the work admits of it. The best possible result is attained when travel of the trolley is effected without varying the vertical position of the load, and without causing useless movement of the hoisting-chain or rope over the sheaves through which it supports the load, which movement would involve much additional friction, and cause rapid wear of the chain or rope. In traveling-cranes a point of great importance is the parallelism of the bridge-travel with the longitudinal tracks. Any defect here results in increased resistance to traction, and any considerable error might cause derailment. In traveling-cranes, as heretofore built, the use of flanged wheels has been relied upon to prevent derailment, and the propulsion of the bridge has been effected by a transverse shaft extending the whole length of the bridge, and connected by gearing with the truck-wheels supporting each end of the bridge, so that, by revolving the shaft, the truck-wheels would be rotated, and the bridge be thereby propelled, provided the adhesion between the wheels and the rails was sufficient. In some instances, where the adhesion has not been sufficient to prevent slipping, a cast-iron rack has been laid adjacent to the longitudinal tracks, and extending their whole length, and pinions, gearing into this rack, attached to the axles of the truck-wheels, so that propulsion is effected independently of the adhesion of the truck-wheels to the track. If the load were always central on the bridge, and the motive power always applied to this shaft at the center of its length, this plan would answer well, although it is somewhat clumsy; but in practice the load is constantly varying in position, and the motive power is applied at one end of the long transverse shaft, so that torsion of the shaft induces a considerable variation in the travel of the opposite ends of the bridge. This error is a constantly varying one, according to the portion of the load resting upon each truck, as determined by the position of the trolley, the load being never equally distributed between the two trucks except when it is exactly in the center. It follows, therefore, that this system of bridge-travel, although operative, is radically defective, and that its use involves a constant loss of power by needless friction, and entails a proportionate amount of wear and tear of rails, wheels, and driving-gear. A better and more simple method of bridge-propulsion has lately been introduced, by means of which the longitudinal motions of the bridge are effected by *pulling* each of its ends, simultaneously and at equal speed, in the desired direction. For this purpose light wire cables are used, which, by a very simple and ingenious arrangement of guide-sheaves, are made to act as a "squaring device" to hold the bridge at all times perpendicular, or square, to the tracks upon which it travels. By this system the friction of traction is reduced to a minimum, and the danger of derailment from unequal travel of the opposite ends of the bridge entirely obviated. From the above facts it becomes evident that a perfect system of bridge-propulsion must hold the bridge always absolutely square with its tracks, and must propel the opposite ends of the bridge in the same direction, at the same time, and at the same speed, however unequally the load may be distributed. It is desirable also that, in large cranes at least, provision be made for starting the bridge slowly from a state of rest, and then increasing the speed, and also for varying the speed while the bridge is in motion.



Chain-wheel, Guide, and Stripper.

In almost every type of crane the load is primarily carried upon a flexible cord of some kind. This usually consists of rope, either hemp or wire, or of chain. Each of these has distinctive merits and objections. Ropes have the advantage of being formed of many parts or fibers, so that no splicing or welding is necessary in their manufacture, and they thus have an assured and practically uniform strength throughout their length. Chains, on the contrary, consist of a series of independent links, each of which is formed from a straight bar, and welded, so that a single imperfect weld injures the whole, the strength of a chain being obviously limited by the strength of its weakest link. By care and good workmanship, however, this danger can be avoided, in which case the chain becomes as safe as the rope, and much more durable. Where a rope is used, the hoisting-gear must necessarily include a drum or barrel upon which the rope is wound up when hoisting takes place. Chain may also be thus wound up on a barrel, and this has heretofore been the common practice when chains have been employed in crane-construction, and a prominent feature in cranes of large capacity has usually been a proportionately large "winding-barrel" to receive the chain. A chain, however, admits of another mode of construction, which consists in substituting for the wide barrel or drum a pocketed "chain-wheel," consisting of a narrow wheel or sheave, of a width only slightly greater than that of the chain, and having formed upon its periphery a series of indentations or "pockets," exactly corresponding in size and shape with the links of the chain, so that the chain and the pockets fit together accurately, and slipping of the chain upon the chain-wheel becomes impossible. It thus follows that rotation of the chain-wheel causes positive motion of the chain at a speed equal to the circumferential velocity of the wheel, in a manner precisely similar to the motion of a rack driven by a pinion, or of one spur-wheel driven by another.

The best material for the chain-wheel has been found, by experience, to be soft cast-iron, as this causes the least wear upon the chain, and as it is of course best to have the wear come upon the wheel (which is easily and cheaply replaced) than upon the chain. In all of the several types of cranes, the chain-wheels are made and inserted so as to be easily replaced. This, however, does not require to be frequently done, as the wheels will usually endure five or six years of constant use before wearing out. To further insure the proper engagement of the chain-wheel and chain, a chain-guide is provided as shown in the drawing. The functions of this chain-guide are (1) to cause the chain to enter properly into engagement with the wheel; (2) to hold it in engagement with several of the pockets of the wheel, so that the strain upon the chain is distributed over these several pockets, and "stripping" of the wheel prevented; and (3) to permit the lower half of the wheel to be used for engagement with the chain and yet cause the slack side of the chain to follow the wheel up to the horizontal center line again.



Jib-crane Frame.

The construction by which these results are obtained is clearly illustrated in the drawing, in which A represents a pocketed chain-wheel mounted upon the plate or frame B. C is the "chain-guide," enveloping the lower half of the chain-wheel A, and bolted securely to the plate B. The inner curved surface of the chain-guide is grooved, and is of such shape as to leave a space between it and the periphery of the chain-wheel merely sufficient to admit the chain. The latter is thus compelled to enter properly, and is held securely in engagement with the pocketed chain-wheel throughout the arc of contact. At E the chain-guide carries a small roller, over which the slack chain passes downward into a suitable box or receptacle. To insure the proper separation of the chain from the chain-wheel at the point of disengagement there is provided a "chain-stripper." This piece, marked D in the drawing, is also bolted to the plate B, and is provided with a projecting tongue or rib, D', the point of which lies deep in the center groove of the wheel, and thus strips or separates the chain from the wheel as it reaches the proper point, and prevents any clinging of the chain to the wheel. A prolongation of the "stripper" D covers the guidesheave at E and insures the proper passing downward of the chain. The construction of the chain-wheel and its adjuncts, which is above illustrated and described, constitutes a perfect device for hauling in and paying out chain, whether fully loaded or empty, and is moreover easier upon the chain, and more conducive to its endurance, than any ordinary form of winding barrel or drum. With slight modifications, to adapt it to the varying conditions, this construction is embodied in all of the various types of the Weston cranes.

Construction in iron has been adopted almost exclusively for the frames, girders, etc., of the Weston cranes. The great variety of structural shapes of iron which are now obtainable, and the increasing capacity of our rolling-mills to produce shapes of large area and of great length, have greatly simplified and cheapened the building of iron crane frames and girders of moderate sizes. Wherever the dimensions of the work admit, these irons are employed. In machines of larger size resort is had to plate-girders, as described below, while for the columns of large pillar-cranes and similar machines cast-iron in single pieces is employed. The frames of small jib-cranes may frequently be constructed by using a single iron for each of the principal members, in which case the I-beam section is found best. For larger sizes, say from 3 tons upwards, a double frame, each of the principal members being composed of two channel-irons, is found better. The latter construction is shown in outline in the drawing, in which the jib, A, mast, B, and brace, C, are each composed of two channel-irons, separated sufficiently to give proper room for the attachment of the mechanism and to permit the main chains, depending from the trolley, to pass between the two irons forming the jib. The best and most economic construction requires that the brace, C, shall intersect the jib, A, at a distance from the mast equal to four fifths of the extreme effective radius of the crane; that is, that the distance X should be one fourth as great as the distance Y. When for any reason it is necessary that the brace intersect the jib at a point nearer to the mast, as, for instance, at C', as shown by the dotted lines, a much greater depth is necessary in the irons forming the jib, and frequently also in those composing the mast. Where it is possible to obtain greater height of mast above the jib, as indicated by dotted lines at M, a suspension-rod, N, may be substituted for the brace, C, and the latter omitted, thus giving entire freedom below the jib. The intersections of the several members of jib-cranes thus constructed are best united by the overlapping of the web of one part upon the other, and by gusset-plates, all firmly fastened by proper riveting.

In proportioning the frames and girders, such dimensions are adopted as will insure a factor of safety of *six* throughout; that is, such that the strains developed, with the maximum load suspended at the center, or point of greatest strain, shall not exceed one sixth of the breaking strength of the material employed. We state the case in this way for the reason that it is still customary with most engineers to make such calculations upon the basis of an assumed "factor of safety." The best and latest practice, however, is to proportion the parts with reference to the elastic strength of the material employed, and it is the present practice, so far as possible, to give such dimensions to the frames and girders that under no condition shall any of their members be strained to within 50 per cent of the elastic limit of the material. At all intersections of members, and at points of attachment with wrought or cast-iron parts, an excess of strength is always provided to allow for the weakening of bolt and rivet holes and other contingencies. Special attention is given to securing unusual strength and safety in these details of the Weston cranes, all of which are based upon exact and careful calculation. A comparison of one of these cranes with most others of equal nominal capacity will show much difference in the amount and disposition of material employed, so that, although the latter may possibly lift their full nominal load without breaking down, the former may be relied upon to do so always with absolute safety. Doubtless a load of 10 tons could be lifted with a 5-ton crane without disabling it; but in executing a contract to furnish a Weston crane of 10 tons capacity, the builders furnish one proportioned as above explained, and of a strength such as to make it absolutely safe for its intended work. See *Bridge-crane, Column-crane, Derrick-crane, Differential Pulley-block, Hooks, Jib-crane, Locomotive-crane, Pillar-crane, Rotary Bridge-crane, Swing-crane, Take-ups, Traveling-crane, Trolleys,* and *Walking-crane.*

CRANEQUENIERS.—A surname given to the foot-troops who, in ancient times, were armed with the *cranequin.*

CRANEQUIN.—The *windlass crossbow* anciently used by foot-soldiers who were surnamed *cranequeniers.*

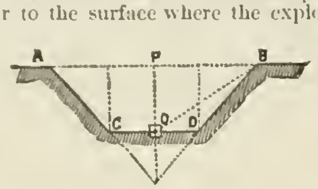
CRANK.—In machinery, an arm or a bend on an axle or shaft which may be driven by a connecting-rod or by the hand, its use being to convert an alternating straight motion into a continuous revolution. A crank may have part of the shaft on both sides, so that one rod may drive two wheels. There are two positions in a crank in which the connecting-rod exercises no power whatever; viz., when the arm of the crank is parallel to the connecting-rod, and again when the crank is at the opposite point of its course. A push or pull of the rod in such circumstances can only press the shaft against its bearings. The effect is greatest when the rod and the crank-arm are at right angles, and it decreases gradually on both sides of that position, until at the top and bottom it is reduced to nothing. In order to carry the crank over these *dead points,* as they are called, a fly-wheel is fixed on the shaft; this receives part of the force of the rod while at its best, acts as a reservoir, and by its stored-up momentum carries the shaft round when the rod is powerless.

CRANNOGES.—The name given in Ireland and in Scotland to the fortified islands in lakes which were in common use as dwelling-places and places of refuge among the Celtic inhabitants. The etymology of the word is uncertain, but it is believed to refer to the timber which was employed either in the fortification of the island, or in the construction of the houses which were placed upon it.

CRAPE.—A thin fabric made of raw silk, which has been tightly twisted, without removing the viscous matter with which it is covered when spun by the worm. It is simply woven as a thin gauze, then dressed with a thick solution of gum, which in drying causes the threads partially to untwist, and thus gives a wrinkled and rough appearance to the fabric.

It is usually dyed black, and is used for mourning-apparel.

CRATER.—The form of the crater in ordinary soils has not been accurately ascertained. The only use of the exact determination of this form would be to calculate precisely the quantity of earth thrown from the crater, and by that means to proportion the charge to the effect to be produced. Different figures have been assigned by Engineers to the solids constituting the crater; some assuming it to be a cone, the center of the powder being taken as the vertex; others, a paraboloid, the center of the powder being the focus, etc. To afford a uniform and simple rule for calculating the volume of the crater, the solid will be assumed as a truncated cone, the radius, O D, of the lower circle, being also assumed at one half the radius, P B, of the upper circle. The radius, P B, of the upper circle is termed the *crater radius;* the line, O P, drawn from the center of the powder perpendicular to the surface where the explosion takes



Section of Crater.

place, the *line of least resistance;* and the line, O B, drawn from the same center to any point in the circumference of the upper circle, *the radius of explosion.*

It was for a long time supposed by miners that a crater could not be formed with a radius greater than twice the line of least resistance with any charge; but the experiments of Belidor have shown that, by successive augmentations of the charge, the crater radius may be increased to six times this line, but not much beyond; that within this limit the ratio of the diameters of the craters is nearly that of the square root of the charges; and that galleries can be destroyed by such mines at distances of four times their line of least resistance. The physico-mathematical theory of mines is still very imperfect, owing to the impracticability of ascertaining the exact effects of the explosion of powder in a medium which is seldom homogeneous, and the resistance of which, arising from its tenacity, compressibility, etc., to the expansion of the gases, can only be arrived at by a wide range of experiments made with minute care. From the want of these elementary data, the formulæ at present in use, to determine the charges for different media, are necessarily empirical, and their results are to be relied on only within the limits in which they coincide with experiments. For most cases in practice these approximations are near enough, and valuable as the only guides that the miner has to refer to. See *Mines.*

CRAVAT.—A part of the uniform prescribed for officers in the United States army. The cravat is black, and the tie is not permitted to be visible at the opening of the collar. Neither cravats nor stocks are worn by the enlisted men when on duty.

CREEDMOOR RIFLE-RANGE.—The largest and most complete rifle-range in the United States. It is a station on the Long Island Railroad, about 10½ miles east of New York, was established in 1871, and is much frequented by riflemen for target practice.

CREESE.—A Malay dagger, generally with a wavy or *flaming* blade, which the Malay tribes render still more fatal by dipping into poison. Sometimes written *Crease, Cressit, Cris, Krees,* and *Kris.*

CREMAILLE.—In field-fortification, the term *cremaille* is employed when the inside line of the parapet is broken in such a manner as to resemble the teeth of a saw. This advantage is gained by the measure that a greater fire can be brought to bear upon the defile than if only a simple face was opposed to it; and consequently the passage is rendered more difficult.

CREMAILLERE LINE.—An indented line, consisting of long and short branches, which may be arranged as shown in the drawing. The long branches are usually made 70 yards long, or more, and are directed towards ground which cannot be occupied


Crémaillère Line.

by an enemy. The short branches are made about 30 yards long, and are used to flank the long branches. Instead of giving the long branches directions parallel to each other, they may all be directed upon a single point, which the enemy cannot reach. See *Lines.*

CRENAUX.—In fortification, small openings or loop-holes, made through the walls of a fortified town or place. They are extremely narrow towards the enemy, and wide within; so that the balls from the besiegers can scarcely even enter, whereas two or three soldiers may fire from within.

CRENEL—CRENELLE.—A term sometimes used for a battlement, but more frequently for the embrasures in a battlement. The adjective *crenellated* is in frequent use to signify that a building is supplied with crenelles. See *Battlement.*

CRENELLE.—In Heraldry, a term meaning embattled, and used to signify that any ordinary is drawn like the battlements of a wall. See *Heraldry.*

CREPIDA.—The iron-shod shoe worn by the early Greek philosophers and soldiers. It did not cover the whole of the foot.

CRESCENT.—1. A musical instrument consisting of a staff with arms and suspended bells, used in a band.—2. In Heraldry, the crescent is used both as a bearing or charge, and as a difference, or mark of cadency. In the latter case it designates the second son and those that descend from him.—3. A representation of the half-moon with the horns turned upwards, called a crescent, is often used as an emblem of progress and success. It is generally spoken of as "The Arms" of the Turkish Empire, but is more properly the emblem of the Empire and people—not a very appropriate one in our day. It was, however, the emblem of the Greek before it became that of the Turkish rule; and at the present day is frequently to be seen on churches in Moscow and elsewhere in Russia, generally surmounted with the cross, marking unquestionably the Byzantine origin of the Russian Church.—4. The name of three orders of knighthood. In 1799, after the battle of Aboukir, the Sultan Selim III. testified his gratitude to Nelson by sending him a crescent richly adorned with diamonds. It was not intended as an order, but Nelson wore it on his coat, and on several occasions called himself the Knight of the Crescent. Selim was flattered by the value which the English Admiral, already decorated with so many orders, seemed to attach to his gift; and it was this circumstance which determined him, in 1801, to found the Order of the Crescent. Mohammedans being forbidden, in the Koran, to carry such marks of distinction, the order is conferred only on Christians who have done service to the State. The second person on whom it was conferred was General Sebastiani, for his defense of Constantinople against the English fleet in 1807. The insurrection of the Janissaries suspended the efforts at Europeanizing which Selim had begun; and when they were resumed by Mahmud, he instituted several other decorations. There was an old Order of the Crescent instituted at Algiers by René, Duke of Anjou, brother and heir of Louis III., King of Naples, in 1464. Its objects were those common to the religious military orders of those days: the honor of God, the defense of the Church, the encouragement of noble actions, and the glory of the founder. The Dukes of Anjou and

Kings of Sicily were sovereigns of the order. The badge was a crescent of gold, on which was the word Loz, enameled in red letters, the import being Loz (laus) en Croissant—Praise by Increasing. Like many other orders founded by the smaller sovereigns, the Order of the Crescent did not survive the founder. See *Cadency*.

CREST.—1. In fortification, the intersection of surfaces making a salient angle with the plane of site. 2. Though popularly regarded as the most important feature in heraldic emblems, the crest, in the eyes of heralds, is an external adjunct to the shield, without which the bearing is complete, and which may consequently be altered without materially affecting its significance. Occupying the highest place on the helmet, it is the member of the bearing by which the knight was commonly known in battle; and from this circumstance it is to it that the term *cognizance* (from *cognosco*, to know) is properly given. Its claim to a classical origin is probably better than that of any other portion of coat-armor. Jupiter Ammon is represented as having borne a ram's head on his helmet, and Mars the figure of a lion or a tiger. Alexander the Great, on the pretense that he was sprung from Jupiter, assumed the ram's head; and Julius Cæsar bore a star, to denote that he was descended from Venus. The helmet, as we see it represented on ancient statues and gems, was frequently adorned with a crest. Sometimes it was of horse-hair; at other times a lion or other animal was placed on the helmet, either erect or couchant. Newton, in his *Display of Heraldry*, says that the first crest to be met with in the monuments of English chivalry is that on the great seal of Richard Cœur de Lion. The helmets in this instance, and in that of Roger de Quincy, Earl of Winchester, differ in form from those afterwards used, the crest occupying a much larger space. Crests are said to have come into general use about the time of Henry III., and to have been used as marks of distinction by Commanders in the Holy Wars, as they had formerly been by the Roman Centurions. For lightness they were often made of stuffed leather, which was gilt, silvered over, or painted — a circumstance which explains their greater size then than in later times, when they were made either of wood or metal. The earliest example of the wreath on which the crest is now invariably placed is that on the monument of Sir John Harsick. It consisted of two pieces of silk, of the colors of the armorial bearings of the wearer, twisted together by the lady who had chosen him for her knight. Though crests are now invariable appendages to shields, and many of them are appropriated to particular families by hereditary descent, they are believed to have been originally assumed at the pleasure of the wearers; and they are even now less strictly under the cognizance of the heralds than the devices on the shield, which must always be assigned by competent authority. Crests are so various that a classification of them is scarcely possible. The following is an abridgment of that given by Newton, who has written very fully on the subject. The most ancient class of crests he believes to have consisted of ferocious animals, which were regarded as figuratively representing the bearer and his pursuits. Secondly, they were devices assumed as memorials of feats of chivalry, and for the purpose of perpetuating traditions and family legends, either in addition to or differing from those represented on the shield. Thirdly, they served only to give a more prominent place to objects already represented on the shield. Fourthly, they commemorated religious vows, or expressed the religious or knightly aspirations of the bearer. Fifthly, they were mere whims, and were adopted for no very definite reason, and served no very definite purpose. As many of them belonged to persons not only unconnected by family, but having different names, they no longer served the purpose of distinction when separated from the shield. To this latter class belong the vast majority of modern crests assumed at the suggestion of seal-engravers and coach-painters.

Helmet and crest of Roger de Quincy, Earl of Winchester.

CRESTED.—In Heraldry, when a cock or other bird has its comb of a different tincture from its body, it is said to be *crested* of such a tincture, naming the tincture. See *Heraldry*.

CRETE.—The earth thrown out of a ditch in a fortification, trench, etc. The most elevated part of a parapet or glacis.

CRIB-BITING.—A bad habit met with especially in the lighter breeds of horses and those spending a considerable amount of leisure in the stable. The act consists in the animal seizing with his teeth the manger, rack, or any other such object, and taking in at the same time a deep inspiration, technically called *wind-sucking*. Crib-biting springs often from idle play, may be first indulged in during grooming, especially if the operation is conducted in the stall, and the animal be needlessly teased or tickled; is occasionally learned, apparently, by imitation from a neighbor; and in the first instance is frequently a symptom of some form of indigestion. Its indulgence may be suspected where the outer margins of the front teeth are worn and rugged, and will soon be proved by turning the animal loose where he can find suitable objects to lay hold of. It usually interferes with thriving and condition, and leads to attacks of indigestion. It can be prevented only by the use of a muzzle or throat-strap; but in those newly acquired cases resulting from gastric derangement, means must further be taken to remove the acidity or other such disorder. See *Veterinary Art*.

CRIB-STRAP.—A neck-throttler for crib-biting and wind-sucking horses.

CRIME.—In its legal as opposed to its moral or ethical sense crime is an act done in violation of those duties for the breach of which the law has provided that the offender, in addition to repairing, if it be possible, the injury done to the individual, shall make satisfaction to the community. A private wrong or civil injury, on the other hand, is an infringement on the rights of an individual merely, for which compensation to him is held, in law, to be a complete atonement. From this definition, which is that generally adopted by lawyers, it is obvious that legal criminality is not a permanent characteristic attaching to an action, but one fixed upon it arbitrarily, from considerations of expediency. Without changing its moral character, the same action may, and very often is, a crime in one country or in one generation, and no crime in another country or a succeeding generation. Malice, or evil intention, however, is in all cases essential to the character of crime, for, though there may be an immoral act which it is inexpedient to punish as a crime, it can never be expedient to punish as a crime what is not an immoral act. But it is not necessary that the evil intention shall have had reference to the party injured. If the offender acted in defiance of social duty, and regardless of order, a crime has been committed, though it may not have been the particular crime which he intended. For example, it is murder if A kill B by mistake for C, unless the killing of C would have been justifiable or excusable. The law can take no cognizance of a bare intention which has not ripened into any sort of act. How far *attempts* to commit crime are punishable is always a question of difficulty. The general rule seems to be, that if such acts can be unequivocally connected with the criminal intention, they are punishable, though not to the same extent as the completed crime. Pupils under seven years of age, and insane persons, as being incapable of design or intention, are regarded in the eye of the law as incapable of crime; but questions as to the responsibiity of persons laboring under partial insanity are often surrounded with practical difficulties, which are positively insoluble. The defense of *compulsion*, or *vis major*, as it is called by lawyers, if completely established in fact, is generally sufficient in law. The subjection of a servant to a master, or of a wife or child to a husband or parent, will be no defense for the commission of an act of the criminality of which the offender was aware, unless it amount to compulsion. Magistrates acting *bona fide*, and soldiers acting under their officers in the ordinary line of duty, are not liable to a criminal charge. Extreme want is no excuse for a crime in law, though it furnishes a ground for an application for mercy.

In the technical language of the law of England, the term *offense* has a wider signification than crime, the latter including only such of the former as are punishable by *indictment*. Crimes are divided into *misdemeanors* and *felonies*, the latter being a higher species of offense than the former. For the specifications of crimes, capital and military, see *Articles of War*.

CRIMPING-HOUSES.—Houses in which persons were entrapped into the army; hence the name of "Crimp Sergeant." In a riot in London some of these receptacles were destroyed by the populace, in consequence of a young man who had been enticed into one being killed in endeavoring to escape, September 16, 1794.

CRINED.—A term in Heraldry. When the hair of a man or woman, or the mane of a horse, differs in tincture from the rest of the charge, the object is said to be *crined*, of such a metal or color. See *Heraldry*.

CRINIERE.—Small plates of armor used in the Middle Ages to defend the necks of war-horses. Also written *Manifère*. Sometimes written *Crinet*.

CRIQUES.—Small ditches which are made in different parts of a ground for the purpose of inundating a country, in order to obstruct the approaches of an enemy.

CROATS.—In military history, the light, irregular troops; generally people of Croatia. They were ordered upon all desperate services, and their method of fighting was the same as that of the Pandours.

CROCHERT.—A hagbut or hand-cannon anciently in use. Now obsolete.

CROCUS.—A polishing-powder composed of peroxide of iron. It is prepared from crystals of sulphate of iron, calcined in crucibles. The portion at the bottom, which has been exposed to the greatest heat, is the hardest, is purplish in color, and is called *crocus*. It is used for polishing brass or steel. The upper portion is of a scarlet color, and is called *rouge*. It is used for polishing gold, silver, and speculum metal. *Rouge*, the cosmetic, is made from safflower, or from carmine, which is a preparation of cochineal.

CROOK.—A circular tube belonging to band-instruments, such as the French horn or trumpet, which fits into the end of the instrument next the mouthpiece, for the purpose of making the pitch of the instrument suit the key of the music; the notes of the parts for these instruments being always written in the natural key of C, with the name of the key of the piece marked in letters.

CROSS.—1. The Order of the Cross was originally a spiritual order of knighthood, which sprang up in Palestine in the time of the Crusades, and was then called the *Bethlehemite Order*. After the commencement of the thirteenth century, the knights of this Order adopted the monastic life, settling chiefly in Austria, Bohemia, Moravia, Poland, and Silesia. Pope Gregory IX. confirmed the Order in 1328. Its principal seat is now in Bohemia, and its members generally hold ecclesiastical preferments or professorships in the University of Prague. They are distinguished by a cross of red satin, with a six-pointed star under it, and are sometimes called *Stellieri*.

2. A term in Heraldry. If we assume the art of blazon to have originated in connection with the Crusades, it will not surprise us to find the symbol of the Christian faith so frequently introduced into the escutcheons of ancient and noble families everywhere in Europe. It is one of the honorable ordinaries, and indeed, from its sacred character, is esteemed by heralds as the most honorable charge. Its form varies so much that Ménestrier counts 42 crosses; La Colombière, 72; and Guillim, 39. Most of the architectural crosses occur in Heraldry, along with many others. See *Victoria Cross*.

CROSS-BAR SHOT.—A shot which is folded into a sphere for loading, but on parting from the muzzle is expanded into a cross with sections of the shot at the extremities of the arms.

CROSS-BELTS.—Belts worn over both shoulders and crossing the breast, usually worn by Sergeants.

CROSS-BOW.—An ancient weapon of offense of the eleventh century. The cross-bows of the cavalry were lighter than those of the infantry, and the string was stretched by means of a simple lever, called a *goat's-foot*. There are seven different sorts of this weapon, viz., the *goat's-foot cross-bow*, the *windlass cross-bow*, the *latch cross-bow*, the *German cross-bow*, the *cross-bow à galet*, the *ramrod cross-bow*, and the *Chinese cross-bow*. The wood most sought after in France for the making of bows was the yew; and in Charles VII.'s time (1422–1463) a law was passed for the planting of yew-trees in all the Norman churchyards, so that wood might never fail for the new weapon, which was then in great favor. The bow was used until the introduction of fire-arms and guns; even later it was still popular, and preferred to the cross-bow. The Scythians, Cretans, Parthians, and Thracians were as much celebrated in ancient times for their skill in the handling of this weapon as the English archers were during the Christian Middle Ages. See *Archers*.

CROSS-BOW A GALET.—A cross-bow of the sixteenth century, so called from the round pebbles, leaden bullets, and earthenware balls that were shot from it instead of bolts. It was called *balestre* by the Germans.

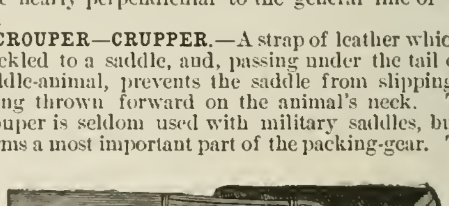
CROSS-FIRE.—The crossing of lines of fire from two or more points or places. See *Fire*.

CROSS-GUARD.—The transverse bar that forms a cross with the blade and the barrel of a sword, at their point of junction.

CROSS-LIFT.—To cross-lift a piece or other object is to cross handspikes under it from opposite sides; the butt end of the handspike is on the ground, and the power is applied by lifting at the other end. By cross-lifting, the piece is moved in a direction nearly at right angles to its axis. See *Mechanical Maneuvers*.

CROTCHET. 1. In fortification, an indentation in the glacis of the covered-way at a point where a traverse is placed. 2. The arrangement of a body of troops, either forward or rearward, so as to form a line nearly perpendicular to the general line of battle.

CROUPER—CRUPPER.—A strap of leather which is buckled to a saddle, and, passing under the tail of a saddle-animal, prevents the saddle from slipping or being thrown forward on the animal's neck. The crouper is seldom used with military saddles, but it forms a most important part of the packing-gear. The



tendency of the aparejo to work forward is overcome by a wide crouper (the dock-rest being of soft and round leather to avoid galling) attached to its outside and passing back over the hips. It should be carefully adjusted and always kept clean. See *Packing*.

CROUPIERES.—Armor placed on the buttocks and haunches of war-horses in the Middle Ages, to protect them against the arms of the adversary.

CROWBAR.—An iron bar used as a lever to move heavy weights in mechanical maneuvers, drills, etc.

CROWN.—As the emblem of sovereignty in modern Europe, the crown was borrowed rather from the diadem than the crowns of antiquity. This decoration was originally Oriental. Alexander the Great adopted it from the Kings of Persia; and Antony assumed it during his luxurious intercourse with Cleopatra. According to some, its adoption for the gods originated in the fillet, which was assigned to Bacchus for the purpose mentioned as that which led to the use of the convivial crown. In modern States, crowns were of very various forms, till heralds devised a regular series of them to mark the various gradations of sovereignty, from that of the Emperor down to what are now called the coronets of counts and barons. The Pope also had his triple crown. So entirely was the crown regarded as the symbol of sovereignty that the word came often to be used as synonymous with the Monarchy—a sense in which we will still speak of the Crown of England, and the domains and possessions of the Crown.

The crowns of kings and emperors are closed above, whilst the coronet of a noble is merely an open circle surrounding the head; hence *to close the crown* has been the ambition of princes desirous of shaking off the authority of feudal superiors and assuming a complete sovereignty.

CROWNING OF THE COVERED-WAY.—Having reached, during the *third period* of the siege, to within some six yards of the crest of the covered-way bordering the ditches, and from which the scarps of the works to be breached can be seen, and their ditches commanded and enfiladed, a trench is pushed forward from each of the direct approaches parallel to and within five or six yards of the crest. As this trench necessarily leads towards the retired parts, it will be more or less exposed to a commanding enfilading fire from points nearly in its line of direction, and to a slant and more or less reverse fire, from each of which it will be necessary to cover it by ordinary and wing traverses; besides which it will be well in some cases to run out to the rear flanking ends of trenches, and when the re-entering itself is deep it may be found necessary to connect these trenches, making a continuous line or secondary parallel within the salient points gained. This trench, when bordering the crest of the covered-way, is termed the *crowning of the covered-way*, and, as has been shown, it may be effected either under an open assault or by a systematic approach by sap.

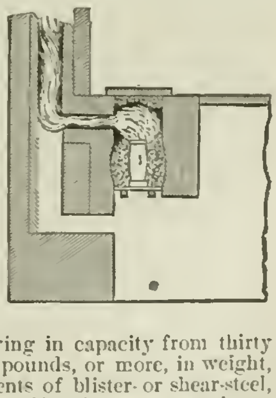
When the crowning of the covered-way is completed, or whilst in progress, preparations are made for constructing batteries to open breaches in the main works, and for counter-batteries to control the fire of any guns which the besieged, taking advantage of the paralyzed state of the batteries in front of the first and second parallels, from the obstruction offered by the approaches in advance of the third parallel, and even by the parallel itself, may now put in position. The positions given to the counter-batteries are usually such as to fire in the directions of the ditches and against the portions of the main work by which these are swept, and those of the breach-batteries will be as nearly opposite as practicable to the points where it is deemed best to open breaches. The counter-batteries are thus usually thrown around the salients, and the breach-batteries are placed further in, but still near the counter-batteries, as they are less exposed here to plunging or reverse fire than if placed further in. The principal point to be observed is that the breach when made shall be wide enough for the front of the assaulting column, be practicable or of easy ascent, and open the interior of the work throughout the entire width of the breech. The wider the breach, of course the better, but one of thirty yards width is considered a formidable gap for the besieged to attempt to close, with troops alone, to oppose an assaulting column. See *Siege*.

CROWN-WORK.—The crown-work, in a permanent fortification, consists of two or more bastioned fronts, with their outworks, placed in front of some portion of the enceinte, to give it additional strength. It is terminated like the horn-work by two wings, which rest either upon the enceinte, or upon two demi-lunes. Its covered-way, like that of the horn-work, forms a continuous communication with that of the enceinte. Certain arrangements of the bastioned lines give rise to the bridge-heads known as *horn-works* and *crown-works*. Let a point be taken in front of the bridge and some distance from it. Through this point let a right line be drawn perpendicular to the general direction of the bridge. On this line thus drawn as an exterior side let a bastioned front be constructed, and its salients be joined with the banks of the river by straight lines, which are so directed that they can be swept by a fire from the opposite bank. The resulting trace is known as a horn-work. It is plain that this work will only be used when the main approach to the bridge lies in the prolongation of its length.

If through a point assumed in front of the bridge two right lines were drawn making an angle with each other, and prolonged until they reached the banks of the river, and on these two lines, as exterior sides, bastioned fronts were constructed, the resulting trace would be that of a crown-work. It is plain that this trace will be employed when the approaches to the bridge are oblique to the direction of the bridge, and that the enemy would use one as quickly as the other. If there are several approaches, and the entire front is exposed to attack, a continued bastioned line might be used, inclosing the space in front of the bridge from bank to bank. In this case, if a salient occupies the central position, the line is known as a crown-work. In the latter case it is called a *complex crown-work*, to distinguish it from one constructed on two sides only, which is called *simple* crown-work. See *Horn-work*.

CROW'S-FEET.—Obstacles placed on the ground over which cavalry may be expected to pass. They are formed of four points of iron, each spike about two and a half inches long, and so arranged that when thrown on the ground one of the points will be upwards. Boards, with sharp nails driven through them, may supply the place of crow's-feet. The boards are imbedded in the ground, with the sharp points projecting a little above it. See *Accessory Means of Defense* and *Calthorp*.

CRUCIBLE-STEEL.—The best and most uniform quality of steel can only be obtained by fusion. That obtained by cementation is, as a rule, very unequal in quality; and uniformity can only be attained by repeated fagoting and welding, steps which are necessarily attended with a loss of carbon and consequent reduction of hardness. The requisite uniformity of composition may, however, be obtained by breaking up the crude bars produced in the forge or by cementation, and exposing them to a high degree of heat in crucibles out of contact with the air. The product, when melted, is poured out into cast-iron molds forming ingots of *crucible-steel*, which are very much more regular in both composition and texture than the original material.



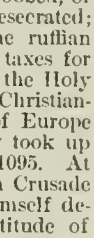
Crucibles of very refractory fire-clay, mixed with plumbago, varying in capacity from thirty to fifty and a hundred pounds, or more, in weight, are charged with fragments of blister- or shear-steel, and placed in furnaces. The furnaces, as shown in the drawing, are furnished with covers, and a chimney which increases the draught of air, and the crucibles are furnished with lids of clay to exclude the air. The furnaces containing the crucibles are filled with fuel; and for the perfect fusion of the steel the most intense heat is kept up for two or three hours. When the steel is thoroughly melted the crucibles are removed either by hand or machinery, and their contents poured, in the liquid state, into ingot-molds of the shape and size required. When the crucibles are emptied, if sound, they are returned to the mixing-room again, and charged.

Although steel may be cast into ingots, it is too imperfectly fluid to be cast into very small articles. The ingots of steel are taken to the forge or rolling-mill, and prepared by hammering or rolling into shape in the same manner as other steel, but with less heat and with more precaution. The great secret of the manufacture is in the selection and mixture of irons, and in the pouring of sound ingots. Large castings are made by emptying a sufficient number of large crucibles into an immense ladle placed over the mold; the ladle is then tapped from the bottom. Great skill in melting and pouring the metal, and particularly in heating and forging such great masses, without burning them on the outside or failing to condense them to the core, is of obvious importance. Steel, like iron, is improved by hammering and rolling; consequently when a large cast-steel block is required of great tenacity for a particular purpose, the metal is not run into a mold of the shape and size of the required finished dimensions, but it is cast into a short, thick ingot, and then hammered and drawn to the required finished dimensions, or it is rolled to the required shape between the rollers.

The drawing down of a heavy ingot requires, first a uniform heat throughout the mass; and, to soften the center of such a casting without burning the outside, a moderate and steady temperature maintained for several days; secondly, the effect of the hammer must be felt at the center of the mass, instead of being confined to the outside. A light blow would be absorbed in changing the figure of the surface-metal, and in breaking and distorting the grain, while a great weight falling from a moderate height would be resisted by the whole mass of the forging, and thus felt at its center. See *Cast-steel* and *Steel*.

CRUSADES.—The name given to the Religious Wars carried on during the Middle Ages between the Christian Nations of the West and the Mohammedans. The first of these was undertaken simply to vindicate the *right* of Christian pilgrims to visit the Holy Sepulcher. On the conquest of Palestine, however, the *object* of the Crusades changed, or at least enlarged, and the efforts of the subsequent Crusaders were directed to the rescue of the whole land from the Saracens, who had repossessed themselves of it. From an early period in the history of the Church, it was considered a pious act to make a pilgrimage to the Holy Sepulcher, and to visit the various spots which the Saviour had consecrated by his presence. When Palestine was conquered by the Arabs in the seventh century, that fierce but generous people respected the religious spirit of the pilgrims, and allowed them to build a church and hospital in Jerusalem. Under the Fatimides of Egypt, who conquered Syria about 980 A.D., the position both of the native Christian residents and of the pilgrims became less favorable; but the subjugation of the country, in 1065, by brutal hordes of Seljuk Turks from the Caucasus rendered it intolerable. These barbarians, but recently converted to Mohammedanism, were nearly as ignorant of the Koran as of the Scriptures. They hardly knew their fellow-religionists, and are said to have wreaked their vengeance on the Mussulmans of Syria, as well as on the Christians. The news of their atrocities produced a deep sensation over the whole of Christendom. The first to take alarm were, naturally enough, the Byzantine Monarchs. In 1073, the Greek Emperor Manuel VII., sent to supplicate the assistance of the great Pope, Gregory VII., against the Turks, accompanying his petition with many expressions of profound respect for His Holiness and the Latin Church. Gregory—who beheld in the supplication of Manuel a grand opportunity for realizing the Catholic unity of Christendom—cordially responded; but circumstances prevented him from ever carrying the vast designs which he entertained into execution, and the idea of a Crusade died gradually away. It was, however, revived by his successor, Urban II., an able and humane man, whose sympathies were kindled by the burning zeal of Peter the Hermit, a native of Amiens, in France, who had made a pilgrimage to the Holy Land, witnessed the cruelties perpetrated by the Turks, and was now traversing Europe, preaching everywhere to crowds in the open air, and producing the most extraordinary enthusiasm by his impassioned descriptions of how Pilgrims were murdered, robbed, or beaten; how shrines and holy places were desecrated; and how nothing but greed restrained the ruffian Turks (who made the Christians pay heavy taxes for their visits to Jerusalem) from destroying the Holy Sepulcher and extirpating every vestige of Christianity in the land. As soon as the feelings of Europe had been sufficiently heated, Urban openly took up the question. Two Councils were held in 1095. At the second, held at Clermont, in France, a Crusade was definitely resolved on. The Pope himself delivered a stirring address to a vast multitude of clergy and laymen, and as he proceeded the pent-up emotions of the crowd burst forth, and cries of *Deus vult* (God wills it) rose simultaneously from the whole audience. These words, *Deus vult*, by the injunction of Urban, were made the war-cry of the enterprise, and every one that embarked in it wore, as a badge, the sign of the cross; hence the name *Crusade*.

CRUSHER-GAUGE.—An instrument employed for determining the pressure of the powder in the bore of a gun. It is so constructed as to register the maximum pressure of the powder-gas at the particular point in the bore where the apparatus is placed. As used in England, it consists of a screw-plug of steel with a movable base, which admits a copper cylinder; one end of the cylinder rests against an anvil, while the other is pressed by a movable piston, kept against the cylinder by an annular spring; the cylinder is centered in the chamber by a small watch-spring, to prevent the escape of gas to the chamber; the head of the piston and body of the anvil are fluted; four small holes communicate with the main vent through the upper part of the plug; a gas-check is placed against the lower end of the piston. The action of the gauge is as follows: The gas, acting on the piston, crushes the copper cylinder against the anvil; the amount of compression it sustains indicates the pressure. The area of the copper cylinder for 8-inch guns is $\frac{1}{12}$ of a square inch; that of the piston being $\frac{1}{4}$ of a square inch. A table of results to produce definite amounts of pressure by the testing-machine affords a means of comparison of the results produced in the gun at different points of the bore. See *Pressure-gauge*.



CRUSHING-FORCE.—The samples submitted to the test of compression are small cylinders, the lengths of which are generally two and a half times their diameters. Bars of greater length than these diameters are liable to bend under the pressure before the fracture occurs; and if the lengths be less than two diameters, the fracture in its regular form may not be fully developed, and a portion of the sample may be pulverized or reduced to small grains. The ends of each sample are made perfectly parallel and perpendicular to the axis, so that all parts of the sample will be equally pressed. The dimensions of the sample are carefully measured before placing it. The depression or permanent set at every 5000 pounds, for instance, is then carefully noted. The breaking-weight is recorded, as well as the angle of fracture of the specimen. The strength per square inch will be

$$S = \frac{\text{weight}}{\text{area}}.$$

See *Rodman Testing-machine.*

CRUST.—In a horse, the internal part of his foot which covers the more sensitive parts, and to which the shoe is immediately attached.

CRYPTOGRAPHY.—Secret writing, or writing to understand which the recipient must know the key. Such modes of communication have been in use from the earliest times. The Lacedæmonians, according to Plutarch, had a method which has been called the *scytale*, from the staff employed in constructing and deciphering the message. When the Spartan Ephors wished to forward their orders to their Commander abroad, they wound slantwise a narrow slip of parchment upon the staff so that the edges met close together, and the message was then added in such a way that the center of the line of writing was on the edge of parchment. When unwound, the scroll consisted of broken letters; and in that condition it was dispatched to its destination; the General to whose hands it came deciphering it by means of a staff exactly corresponding to that used by the Ephors. Polybius has enumerated other methods of cryptography. The art was in use also among the Romans. Upon the revival of letters, methods of secret correspondence were introduced into private business, diplomacy, plots, etc.; and as the study of this art has always presented attractions to the ingenious, a curious body of literature has been the result. John Trithemius, the Abbot of Spanheim, was the first important writer on cryptography. His *Poligraphia*, published in 1500, has passed through many editions, and has supplied the basis upon which subsequent writers have worked. It was begun at the desire of the Duke of Bavaria; but Trithemius did not at first intend to publish it, on the ground that it would be injurious to public interests. The next treatises of importance were those of John Baptist Porta, a Neapolitan mathematician, who wrote *De Furtivis Literarum Notis*, 1563; and of Blaise de Vigenere, whose *Traité des Chiffres* appeared in Paris in 1587. Lord Verulam proposed an ingenious system of cryptography on the plan of what is called the double cipher; but while thus lending to the art the influence of his great name, he gave an intimation as to the general opinion formed of it and as to the classes of men who used it; for when prosecuting the Earl of Somerset in the matter of the poisoning of Overbury, he urged it as an aggravation of the crime that the Earl and Overbury "had ciphers and jargons for the King and Queen and all the great men—things seldom used but either by Princes and their Ambassadors and Ministers, or by such as work or practice against or, at least, upon Princes." Other eminent Englishmen were afterwards connected with the art. John Wilkins, subsequently Bishop of Chester, published in 1641 an anonymous treatise entitled *Mercury, or The Secret and Swift Messenger*, a small but comprehensive work on the subject, and a timely gift to the diplomatists and leaders of the Civil War. The deciphering of many of the Royalist Papers of that period, such as the letters that fell into the hands of the Parliament at the battle of Naseby, has by Henry Stubbe been charged on the celebrated mathematician, Dr. John Wallis, whose connection with the subject of cipher-writing is referred to in the Oxford edition of his mathematical works, 1689; as also by John Davys. Dr. Wallis states that this art, formerly scarcely known to any but the Secretaries of Princes, etc., had grown very common and familiar during the civil commotion, "so that now there is scarcely a person of quality but is more or less acquainted with it, and doth, as there is occasion, make use of it."

Schemes of cryptography are endless in their variety. Bacon lays down the following as the "virtues" to be looked for in them: "that they be not laborious to write and read; that they be impossible to decipher; and, in some cases, that they be without suspicion." The principles are more or less disregarded by all the modes that have been advanced, including that of Bacon himself, which has been unduly extolled by his admirers as "one of the most ingenious methods of writing in cipher, and the most difficult to be deciphered, of any yet contrived." The simplest and commonest of all ciphers is that in which the writer selects in place of the proper letters certain other letters in regular advance. This method of transposition was used by Julius Cæsar. He, "per quartam elementorum literam," wrote *d* for *a*, *e* for *b*, and so on. There are instances of this arrangement in the Jewish rabbis, and even in the sacred writers. An illustration of it occurs, Jeremiah xxv. 26, where the Prophet, to conceal the meaning of his prediction from all but the initiated, writes Shehach instead of Babel (Babylon), the place meant; i.e., in place of using the second and twelfth letters of the Hebrew alphabet (*B*, *b*, *l*), counting from the beginning, he wrote the second and twelfth (*sh*, *sh*, *ch*), counting from the end. To this kind of cipher-writing Buxtorf gives the name Athbash (from *a*, the first letter of the Hebrew alphabet, and *th*, the last; *b*, the second from the beginning, and *h*, the second from the end). Another Jewish cabalism of like nature was called Albam; of which an example is in Isaiah vii. 6, where Tabeal is written for Remaliah. In its adaptation to English this method of transposition, of which there are many modifications, is comparatively easy to decipher. A rough key may be derived from an examination of the respective quantities of letters in a type-founder's bill or a printer's "case." The decipherer's first business is to classify the letters of the secret message in the order of their frequency. The letter that occurs oftenest is *e;* and the next in order of frequency is *t*. The following groups come after these, separated from each other by degrees of decreasing recurrence: *a, o, n, i, r, s, h; d, l; c, w, u, m; f, y, g, p, b; v, k, x, q, j, z.* All the single letters must be *a*, *I*, or *O*. Letters occurring together are *ee, oo, ff, ll, ss*, etc. The commonest words of two letters are (roughly arranged in the order of their frequency) *of, to, in, it, is, be, he, by, or, as, at, an, so*, etc. The commonest words of three letters are *the* and *and* (in great excess), *for, are, but, not*, etc.; and of four letters, *that, with, from, have, this, they*, etc. Familiarity with the composition of the language will suggest numerous other points of value to the decipherer.

Bacon remarks that though ciphers were commonly in letters and alphabets, yet they might be in words. Upon this basis codes have been constructed, classified with words taken from dictionaries being made to represent complete ideas. In recent years such codes have been adapted by merchants and others to communications by telegraph, and have served the purpose not only of keeping business affairs private, but also of reducing the excessive cost of telegraphic messages to distant markets. Obviously this class of ciphers present greater difficulties to the skill of the decipherer. Figures and other characters have been also used as letters; and with them ranges of numerals have been combined as the representatives of syllables, parts of words, words themselves, and complete phrases. Under this head must be placed the dispatches of Giovanni Michael, the Venetian Ambassador to England in the reign of Queen Mary, documents which have only of late years been deciphered. Many of the private letters and papers from the pen of Charles I. and his Queen, who were adepts in the use of ciphers, are of the same description. One of that Monarch's letters, a document of considerable interest, consisting entirely of numerals, purposely complicated, was in 1858 deciphered by Prof. Wheatstone, the inventor of the ingenious crypto-machine, and printed by the Philobiblon Society. Shorthand marks and other arbitrary characters have also been largely imported into cryptographic systems to represent both letters and words—commonly the latter. This plan is said to have been first put into use by the old Roman poet Ennius. It forms the basis of the method of Cicero's freedman, Tiro, who seems to have systematized the labors of his predecessors. A large quantity of these characters have been engraved in Gruter's *Inscriptiones*. A correspondence of Charlemagne was in part made upon marks of this nature.

A favorite system of Charles I., used by him during the year 1646, was made up of an alphabet of twenty-four letters, which were represented by four simple strokes varied in length, slope, and position. This alphabet is engraved in Clive's *Linear System of Short-hand*, 1830, having been found amongst the Royal manuscripts in the British Museum. An interest attached to this cipher from the fact that it was employed in the well-known letter addressed by the King to the Earl of Glamorgan, in which the former made concessions to the Roman Catholics of Ireland.

Complications have been introduced into ciphers by the employment of "dummy" letters—"nulls and insignificants," as Bacon terms them. Other devices have been introduced to perplex the decipherer, such as spelling words backwards, making false divisions between words, etc. The greatest security against the decipherer has been found in the use of elaborate tables of letters arranged in the form of the multiplication-table, the message being constructed by the aid of preconcerted key-words. In a letter dated 20th February, 1659-60, Hyde, alluding to the skill of his political opponents in deciphering, says that "nobody needs to fear them if they write carefully in good ciphers." In his next he allays his correspondent's apprehensions as to the deciphering of their letter: "I confess to you, as I am sure no copy could be gotten of any of my ciphers from hence, so I did not think it probable that they could be got on your side of the water. But I was as confident, till you tell me you believe it, that the devil himself cannot decipher a letter that is well written, or find that 100 stands for Sir H. Vane. I have heard of many of the pretenders to that skill, and have spoken with some of them, but have found them all to be mountebanks; nor did I ever hear that more of the King's letters that were found at Naseby, than those which they found deciphered, or found the ciphers in which they were writ were deciphered. And I very well remember that in the volume they published there was much left in cipher which could not be understood, and which I believe they would have explained if it had been in their power." An excellent modification of the key-word principle was constructed by the late Admiral Sir Francis Beaufort; it has been recently published in view of its adaptation to telegrams and post-cards. Ciphers have been constructed on the principle of altering the places of the letters without changing their powers. The message is first written Chinese-wise upward and downward, and the letters are then combined in given rows from left to right. In the celebrated cipher used by the Earl of Argyle when plotting against James II., he altered the position of the words. Sentences of an indifferent nature were constructed, but the real meaning of the message was to be gathered from words placed at certain intervals. This method, which is connected with the name of Cardan, is sometimes called the trellis or card-board cipher. The wheel-cipher, which is an Italian invention, the string-cipher, the circle-cipher, and many others, are fully explained, with the necessary diagrams, in the authorities named above—more particularly by Kluber in his *Kryptographik*.

CRYSTALLIZATION. — Of the various circumstances which affect the strength of cannon-metal, the most important appear to be those which connect themselves with crystallization. It is a law of the molecular aggregation of crystalline solids, that when their particles consolidate under the influence of heat in motion, their crystals arrange and group themselves with their principal axes in lines perpendicular to the cooling or heating surfaces of the solid; that is, in the lines of direction of the heat-wave in motion, which is the direction of least pressure within the mass; and this is true, whether in the case of heat passing from a previously fused solid in the act of cooling and crystallizing on consolidation, or of a solid not having a crystalline structure, but capable of assuming one upon its temperature being sufficiently raised by heat applied to its external surfaces, and so passing into it.

The metals used in gun-construction are crystallizing bodies, which in consolidating obey more or less perfectly, according to their conditions, this law; so that in castings of these metals the planes of crystallization group themselves perpendicularly to the surfaces of external contour; that is, in the directions in which the heat of the fluid metal has passed outwards from the body in cooling and solidifying. Because the crystals of these metals are always small and are never very well pronounced, these directions are seldom very apparent to the eye, but they are not the less real. Their development depends upon—

First—The character of the metal itself; all irons that present a coarse, large-grained, dark, or spangled fracture contain a large proportion of uncombined carbon or graphite, and form in castings of equal size the largest crystals.

Second—The size or mass of the castings; the largest castings presenting for any given variety of metal the largest and coarsest aggregation of crystals, but by no means the most regular arrangement of them, which depends chiefly upon—

Third—The rate at which the mass of the casting has cooled, and the regularity with which heat has been carried off by conduction from its surfaces to that of the mold adjacent to them.

Those castings in which the fluid iron is poured into a nearly cold and very thick mold of cast-iron, whose high conducting power rapidly carries off the heat, present the most complete and perfect development of the crystalline structure perpendicular to the chilled surfaces of the casting. In such, crystals are often found penetrating more than an inch into the substance of the metal, clear and well defined. These prevailing directions of crystalline arrangement may be made more clear to the eye by the accompanying drawings, which show sections of a round and a square bar of cast-iron where the crystallization is well developed. In the round bar the crystals all

radiate from the center; in the square bar they are arranged perpendicularly to the four sides, and hence have four lines in the diagonals of the square—in which the terminal planes of the crystals abut or interlock, and about which the crystallization is always confused and irregular. The result of this arrangement is to create *planes of weakness* where the different systems of crystals intersect.

The size and arrangement of the crystals of a metal have an important influence on its strength. This arises from the fact that the adhesion of the crystals by the contact of their faces is less than the cohesion of the particles of the crystals themselves, and that consequently rupture takes place along the larger or principal crystalline faces. See *Cast-iron Guns*.

CUBICAL POWDER.—This powder is of a regular cubical grain, being formed by cutting the press-cake in two directions at right angles to each other by means of saws. A sample was tested in 1876 with the following results:

Nature of Gun.	Kind of Powder.	Weight of charge.	Weight of projectile.	Velocity.	Pressure.
		Lbs	*Lbs*	*Feet.*	*Lbs.*
8-inch rifle.	Cubical, D = 1.765. G = 56.	35	176	1 446	46,500
9-inch rifle	Cubical, D = 1.765. G = 56.	40	229	1,436	24,750

As tested in the 11-inch rifle, this powder proved "high," a pressure of 28,000 pounds resulting with a charge of only 50 pounds. Each grain of this powder is about .75 inch in size, and the granulation is about 72 to the pound. See *Gunpowder*.

CUBIC EQUATIONS.—A cubic equation containing but one unknown quantity is one in which the highest exponent of the quantity in any term is 3. Every such equation can be reduced to the general form $x^3 + px + q = 0$, in which the coefficient of x^3 is 1, and that of x^2 is zero. Every cubic equation of this form has three roots, all of which may be real, or one only may be real and the other two imaginary. The roots will all be real when p is essentially negative and $\frac{p^3}{27} > \frac{q^2}{4}$ numerically. One root only will be real when p is essentially positive, or when it is negative and $\frac{p^3}{27} < \frac{q^2}{4}$ numerically. If p is essentially negative and $\frac{p^3}{27} = \frac{q^2}{4}$, two of the roots are equal. When one of the roots only is real, the equation may be solved by the following formula, known as Cardan's formula:

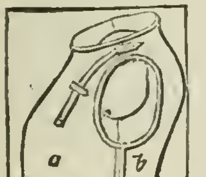
$$x = \sqrt[3]{-\frac{q}{2} + \sqrt{\left(\frac{q^2}{4} + \frac{p^3}{27}\right)}} + \sqrt[3]{-\frac{q}{2} - \sqrt{\left(\frac{q^2}{4} + \frac{p^3}{27}\right)}}.$$

When the roots are all real, this formula fails to give their values. The solving of cubic equations is of frequent necessity in the investigation of the problems of gunnery.

CUBIT.—A measure employed by the ancients, equal to the length of the arm from the elbow to the tip of the middle finger. The cubit of the Romans was about 17⅖ inches, and that of the Hebrews 22 inches, but its length is now generally stated at 18 English inches.

CUGNOT SYSTEM OF FORTIFICATION.—A system having a circular tracing and dispensing with outworks. The revetment of the escarp contains a loop-holed gallery, with machicoulis for the defense of the ditch and the counterscarp. See *Fortification*.

CUIRASS.—The cuirass, as its name implies, was originally a jerkin, or garment of leather for soldiers, so thick and strong as to be pistol-proof, and even musket-proof. The name was afterwards applied to a portion of armor made of metal, consisting of a back-plate and breast-plate hooked or buckled together; with a piece jointed to the back called a *culet* or *garde de reines*. The French cuirass, represented in the drawing, is composed of a breast-plate, *a*, and a back-plate, *b*, joined together by straps. The thickness and form of the breast-plate are such as to ward off small-arm projectiles beyond a distance of forty yards; this distance is assumed under the supposition that within it the infantry soldier will be too busily engaged preparing to defend himself against the cavalry soldier, with his bayonet, to fire his piece. The back-piece is only made of sufficient thickness to resist the stroke of a sword; it is presumed this will induce the wearer to present his front rather than his back, when he arrives within a short distance of his enemy. The middle of the breast-plate is formed into a ridge, and the sides slope off to deflect projectiles coming from the front. The thickness at the ridge is .23 inch; from this it tapers to the edges, where it is .078 inch. The back-piece is .047 inch thick throughout, and the weight of the entire cuirass is about 16.75 lbs. The edges are turned up to prevent the point of a sword from slipping off against the body. The cuirass and helmet worn by the leading sapper in digging a siege-trench are thick enough in all their parts to resist a bullet at the distance of 40 yards. See *Armor*.



CUIRASSIERS.—Heavy horsemen, in the time of Queen Mary, wearing body-armor over buff coats. They carried swords and pistols, and the reins were strengthened with iron chains. In modern armies the name is often given to the heaviest cavalry. Napoleon's twelve regiments of cuirassiers attracted much attention during his wars. The first rank of Russian cuirassiers are armed with lances. The only cuirassiers in the British army (wearing the cuirass) are the Life-guards (red) and Horse-guards (blue); and in these the cuirass is now regarded rather as a matter of show than of use. See *Cuirass*.

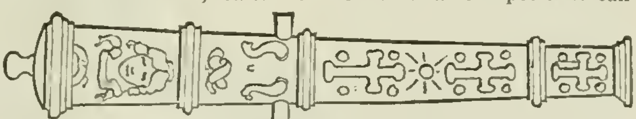
CUISSART.—Among ancient armor, cuissarts were worn by troopers. They consisted of small strips of iron plate laid horizontally over each other round the thigh, and riveted together. Also written *Cuish*, *Cuissard*, *Cuisse*, and *Cuissot*.

CUL-DE-SAC.—A street or alley with an opening at only one end, easy therefore of entrance, but not for exit; thence any very close, confined, uncomfortable place. The expression is applied to a position in which an army finds itself with no way of exit except to the front.

CULLEN RIFLE.—A magazine-gun carrying a great number of cartridges, as many as 40 or 50. This arm has been used to some extent in the United States, but has not met with any considerable success. See *Magazine-gun*.

CULOT.—An iron cup inserted in the conical opening of the Minié and other early projectiles. This *culot*, moving before the inertia of the lead is overcome, forces the ball into the grooves. It has since been discovered that the ball is forced as well without as with the culot, and it has accordingly been suppressed.

CULVERIN.—The introduction of cast-iron projectiles, which are much stronger and denser than those of stone, led to the invention of a new species of cannon called culverins, which very nearly correspond in construction and appearance to the guns of the present day. The great strength of these pieces and their projectiles permitted the use of a large charge of powder; and their introduction proved an important step in the improvement of artillery. The idea was entertained by ancient artillerists—founded on the relation which cannon were erroneously supposed to bear to small-arms—that the range increased with the length of the piece; and in consequence many culverins were made of enormous length. A remarkable piece of this description still exists at Dover, England, familiarly known as "Queen Anne's pocket-piece." While it carries a ball weighing only 18 pounds, it is more than 25 feet long. See *Cannon*.

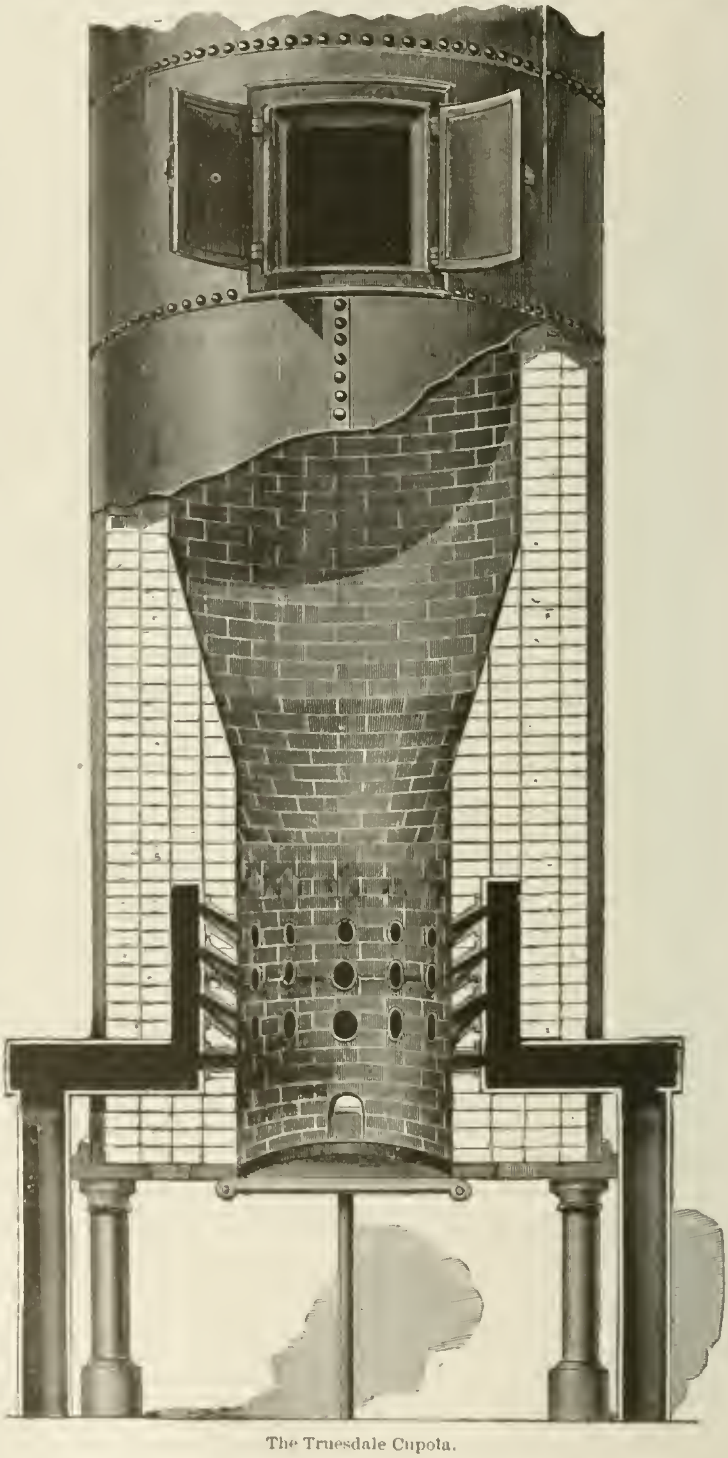


Culverin—"Queen Anne's Pocket-piece."

CUNETTE.—In fortification, the bottom of the ditch, when dry, usually receives a slight slope from the foot of the scarp and counterscarp to its center, where a small drain, termed a *cunette*, is dug to receive the surface-water and keep the ditch dry. In some cases, from motives of economy, the difference of level between the cunette and the foot of the counterscarp-wall is increased, thus giving a less height of wall. This practice, however, can only be followed where the foundations of the wall will be secure, from the soil of the bottom of the ditch being of such a nature as not to yield from the effects of the weather upon it. Also written *Cuvette*. See *Ditch*.

CUPOLA.—A revolving shot-proof turret, formed of strong timbers, and eased with massive iron plates of 12 and 14 inches thick. In some systems of cupolas the tower is erected on a base which is made to turn on its center by means of steam-power. Within the turret heavy ordnance is placed, and fired through openings made in the sides.—The term *cupola* is also applied to a blast-furnace in which iron is melted. See *Cupola-furnace*.

CUPOLA FURNACE.—Many costly experiments have been tried of late years in order to determine, along with other related questions, the best form of blast-furnace in which iron is smelted. Which is the most serviceable form is as yet a very much disputed point; but, according to the published accounts, furnaces of the unusual height of 80 to 100 feet give, as a rule, the best results. To this end it is indispensable that the following conditions are fulfilled: 1. Rapid melting, that the iron may be gotten under the slag as soon as possible, to prevent exposure to the blast, which, at the high temperature in the cupola, rapidly decarbonizes the iron. 2. Uniform combustion in the melting part of the cupola. It is evident that iron melted at different temperatures will vary both in quality and in temperature, and castings poured from such iron will not be uniform in quality or shrinkage. 3. Such an arrangement of the cupola and method of introducing the blast as will maintain the fluidity of all the slag in the cupola, so that it may be drawn off when necessary. It is apparent that when the slag has chilled around and above the tuyeres, drawing off the melted slag below does no good whatever. In most cupolas the blast is introduced at two opposite points; in some cases four and six tuyeres are used, but in the same plane. In very large cupolas from 5000 to 10,000 cubic feet of air per minute are required. This large amount of air introduced at these few points cannot instantly be elevated to the high temperature in the cupola (over 3000° Fahrenheit), consequently combustion is arrested at the entrance, and the slag is chilled by the cold air around the mouth of the tuyere. These obstructions are constantly increased by the melting slag, which cools as it falls, and adheres to those already formed as soon as struck by the blast. If the melting is continued sufficiently long, the entire opening above the tuyeres is bridged over, melting ceases, and the bottom must be dropped. The combustion, under these circumstances, has necessarily been very imperfect. In some parts (as above the chilled slag at the mouth of the tuyeres) the fuel has scarcely been ignited, while in other



The Truesdale Cupola.

parts the heat has been so intense that when the current is forced by the accumulated mass of chilled slag against the lining of the cupola, it is often melted out nearly to the shell. The result is bad iron, great loss in castings, a low percentage of effect for fuel used, and a bad condition of cupola. Another style of cupola is made with continuous tuyeres, in which the blast enters all around the cupola in a sheet. It is well known that neither water nor air can be projected in this way to any considerable distance. To attempt to throw water from a flat nozzle would be simply ridiculous. In cupolas constructed on this plan the blast has but little power to penetrate the stock, but turns upward near its entrance, leaving the stock in the center unsupplied with air. On this account cupolas using sheet-blast are constructed of an oval or oblong shape, bringing their opposite walls closer together, in order that thus the blast may reach the center. It is well known that cupolas, with walls straight or nearly straight, are much weaker and more difficult to keep in repair than the cylindrical form, and require special arrangements to keep the brick in place. If the difficulties encountered in the old-style cupola were obviated by this plan, these evils might be borne; but they are not: the walls being brought nearer together, the liability of bridging over is increased without any compensating benefit. The majority of foundrymen who have tried this construction have gone back to the old style, or have lined them in cylindrical form and substituted the round tuyeres for the sheet-blast.

The drawing shows the Truesdale cupola, in section. In this furnace we find—1. A very considerable contraction of the lower part of the cupola, or that part containing the tuyeres. The blast is thus introduced nearer the center, lessening the distance necessary to force the air, and also the amount of fuel required to make the bed. The boshes or inclines partially support the descending stock, rendering it more open below than above, and on this account the blast is more easily diffused through the entire mass. 2. An important feature is a largely increased number of tuyeres, distributed over a much larger surface. By this arrangement the blast is enabled to penetrate and diffuse itself through every part of the stock, and at the same time is so subdivided that the amount entering at any one place is not so great as to arrest combustion or chill the slag before being elevated to the temperature necessary to enter into combustion. A further advantage is that the cold air entering through the tuyeres protects a certain area of surface about each tuyere, and when placed sufficiently contiguous to each other, as shown in the drawing, the whole interior melting surface is protected. 3. Another important feature in this cupola is the arrangement of graduated tuyeres, each tuyere having the orifice admitting the blast diminished as they ascend in the series. By this means the gas generated by the heat evolved in combustion at the lowest series of tuyeres (a considerable portion of which in its rapid ascent would pass out of the cupola unconsumed) is met by a fresh supply of oxygen and utilized. The same operation is repeated by each tuyere in the series for the one below it. The saving thus effected amounts to ten per cent of the entire amount of fuel burned. An examination of the drawing will give, perhaps, a clear idea of the interior of this cupola during the process of melting. The lower tuyeres in the series having larger openings, and consequently more volume and strength, the blast penetrates further into the stock before ascending than the blast from the next series, which, being somewhat diminished and having less force, ascends before reaching as far inward as the blast from the tuyere below it, and so on through the entire series, the upper set supplying the blast nearest the circumference. It will readily be seen that this arrangement secures the perfect distribution and diffusion of the blast throughout the entire cupola, effecting uniform, rapid, and perfect combustion, with the complete consumption of all the gases generated, without chilling the slag, which, in a fluid state, floats on the melted iron, protecting it from decarbonization. The effects are rapid melting and sharp, with hot iron of a uniformly good quality throughout the entire heat. See *Foundry*, *Iron*, and *Mackenzie Cupola-furnace*.

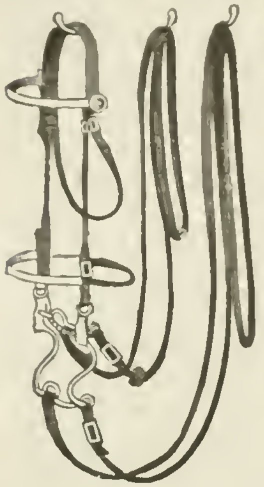
CURARI.—A celebrated poison used by some tribes of South American Indians for poisoning their arrows. It is by means of this poison that the small arrows shot from the blow-pipe become so deadly. The nature and source of this poison remained long unknown, the Indians being very unwilling to reveal the secret, which seems, however, to have been at last obtained from them by Sir Robert Schomburgk, and it is now regarded as pretty certain that the principal ingredient is the juice of the *Strychnos toxifera*, a tree or shrub of the same genus with that which yields nux vomica. It has a climbing stem, thickly covered with long spreading reddish hairs; rough, ovate, pointed leaves, and large, round fruit. The poison, when introduced into the blood, acts on the nervous system, and produces paralysis, with convulsive movements, and death ensues. It is supposed to be the most powerful sedative in nature. Artificial respiration is the most efficacious means of preventing its effects. It has been proposed to employ it in the cure of lockjaw and hydrophobia, and it has recently been asserted, as the result of experiment, that it can be very beneficially employed in the former disease. Like snake-poison, it is comparatively inert when taken into the stomach. Also written *Ourari*, *Woorali*, and *Woorara*. See *Arrow-poisons*.

CURB.—1. A strain of the straight ligament which runs down the back of the hock of a horse. It is most common in animals with straight small hocks and that conformation known as *sickle-hams;* whilst like other strains it occurs from sudden and violent exertion, often proceeding in the lighter breeds from leaping or galloping in heavy ground, and in the heavier from the effort of keeping back a load whilst going down a steep incline. Swelling appears on the inner and back part of the joint, generally causing lameness, which is most apparent in trotting, and, in slight cases, usually wears off after the animal has been out for ten minutes. Fomentations must first be used to allay the irritation and inflammation; when heat and tenderness disappear, cold applications will be advisable; when, after ten days, the enlargement still continues, a blister is generally necessary; whilst, from the first, all work must be forbidden.

2. A funnel-shaped iron border standing out from the incorporating bed of a gunpowder-mill at an angle of 45 degrees, and 2 feet high, serving to keep the charge in the bed, and all extraneous matter out of it.

CURB-BIT.—A stiff bit having *branches* by which a leverage is obtained upon the jaws of a horse. The lower end has rings or loops for the reins, and the upper end has loops for the *curb-chain* and the *cheek-straps* of the head-stall. The curb-chain has usually twisted links, and is fast by one end to the loop of the *off* branch, and is hooked to the loop of the *near* branch. It forms the fulcrum for the leverage of the branches.

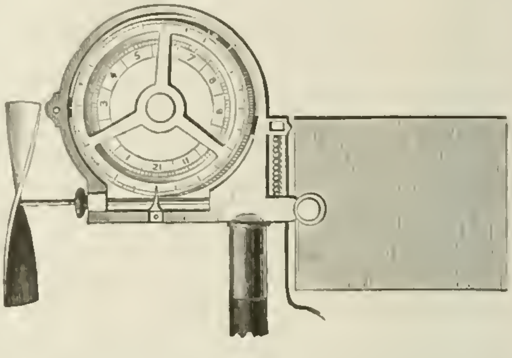
CURB-BRIDLE.—A bridle used in the military service, and having a curb. To put on the curb-bridle, take the reins in the right, the crown-piece in the left hand, approach the horse on the near side, passing the right hand along his neck; slip the reins over his head, and let them rest on his neck; take the crown-piece in the right hand, the left side of the bar of the bit resting on the first two fingers of the left hand; bring the crownpiece in front of and slightly below its proper position, insert the thumb of the left hand into the side of the mouth above the tushes; press open the lower jaw; insert the bit by raising the crown-piece, pass the left hand under the brow-band, draw the ears gently under the crown-piece, beginning with the right ear; arrange the forelock, secure the throat-lash, and then the curb-strap, taking care not to make them set too closely. There should be at least three fingers' breadth between the throat-lash and the jaw, and one finger's breadth between the curb-strap and jaw. The bit should hang so as to touch, but not draw up, the corners of the mouth. In no case should the top of the mouth-piece touch the palate. The halter may be taken off before bridling, the reins being first passed over the neck; if the bridle be put on over the head stall, the hitching-strap, if not left at the manger or picket-line, should be tied round the neck or attached to the left saddle-ring. The hitching-strap may be also arranged as follows: loop it two or three times through the ring, so that the loop may be about eight inches long; wind the strap several times around the loop, and draw the end of the strap tightly through it. See *Bridle* and *Unbridle*.



CURIET.—A breastplate made of leather. The *surcoat* or *jupon*, which usually covered the former styles of armor, was laid aside about the time the cuirass was adopted, say the reign of Edward III. The early cuirass of the Greeks was of linen, which was afterwards covered with plates of horn or scales of horse-hoofs. The Roxalani wore leather with thin plates of iron. The Persians wore a similar cuirass. The Romans introduced flexible bands of steel, folding over one another during the flexure of the body. The Roman *hastati* wore chain-mail (hauberks). The same nation, as well as the Greeks, used the back- and breast plate. See *Armor*.

CURRACH.—The name given in the British Islands to a canoe or boat made of a slender frame of wood covered with skins. Skiffs of this sort, as well as canoes hollowed out of the trunks of oaks, were in use among the Britons in the earliest times of which we have record. Julius Cæsar, who built some of them after the British model, tells us that the keel and gunwales were of light wood, and the sides of wicker, covered with hides. Similar descriptions of the currach are given by Pliny, Lucan, Solinus, Festus Avienus, Sidonius Apollinaris, and others. The first occurrence of the name seems to be in Gildas, who wrote in the sixth century; he speaks of the currach as in use among the Scots and the Picts. A long voyage in the North Sea, made in a currach during the same century, by one of the companions of St. Columba, is commemorated by Adamnan, who died in 704. In 878 three Irish missionaries sailed in a currach from Ireland to Cornwall; the voyage occupied seven days; and the size of the currach is indicated by the remark that it was one of two skins and a half. An old Life of St. Patrick speaks of a currach "of one skin, with neither helm nor oar." The currach of a larger size had a mast and sail. The currach still continues to be used on the Severn, and on many parts of the Irish coast, especially on the shores of Clare and Donegal. The last currach known to have been used in Scotland is in the Museum at Elgin. It was employed on the Spey, towards the end of last century. A boat of bison-skin, essentially the same with the British coracle, is in use among some of the Indians of North America.

CURRENT-METER.—An instrument for measuring the velocity of currents. One form, the *pilot-tube*, acts by the ascension of water in a vent-pipe whose lower orifice is presented squarely to the current, the indication being read by a float or graduation in or upon the vertical part of the tube. Another form acts as a dynamometer, by opposing a resisting body to the action of the current, and indicating the force of the action by a dial or graduated bar. The dynamometer current-gauge of Woltmann (1790) is a light water-wheel operated by the current, and having on its axis an endless screw, which operates toothed wheels and a register, the rate or force being deduced from the rotations in a given time. The drawing



shows this instrument adapted for use in small rivers and streams, or to show the number of gallons flowing from any reservoir or vessel. The mean velocity of water in rivers equals $\frac{(\sqrt{v}-1)^2+v}{2}$, when v is the surface velocity expressed in inches. In the absence of a meter, the surface-velocity may be determined by carefully noting the time required for a chip or any small substance to float a measured distance. The following are the usual expressions applied to river-velocities:

Sluggish,	about 1½ ft.	per second, or	1	mile	per hour.
Ordinary,	" 3	"	2	"	"
Rapid,	" 5	"	3	"	"
Very rapid,	" 8	"	5	"	"
Torrent,	" 9 or more	"	6	"	"

CURRENT SERIES.—In military administration, orders issued from Established Commands, such as Divisions, Departments, etc., being numbered in regular order for each year. This expression is frequently used when referring to orders issued in the year passing or current.

CURRICLE-GUN.—A very small piece of ordnance, mounted upon a carriage of two wheels, and drawn by two horses. The artilleryman is seated on a box, and the whole can be moved forward into action with astonishing rapidity The tumbrils belonging to curricle-guns carry 60 rounds of ball-cartridges. This gun is no longer in general use.

CURRIER.—A very small musketoon with a swivel mounting; but little used at present.

CURRY-COMB.—A kind of scraper used for dressing horses. It consists of a number of iron plates notched on one edge to form rough teeth. These plates are fastened in parallel lines to an iron back, to which a handle is attached, and the horse is "curried" by scrubbing with the teeth.

CURTAIN.—The curtain, in a fortification, is the portion of rampart or wall between two bastions or two gates. In a regular siege, to batter down the curtain is one of the main operations depended on, and many of the external works constructed by the defenders are intended to frustrate, or at least embarrass, this operation See *Bastioned Forts*.

CURTAIN-ANGLE.—The angle of a fortification between the flank and curtain. See *Bastioned Forts* and *Curtain*.

CURTAL-AXE.—A short sword with a curved blade. The name has been modified from time to time: *coutal-hache*, *coutal-axe*, *curtle-axe*, *curtal-axe*, *coutelace*, *curte-lasse*, and *cutlass*.

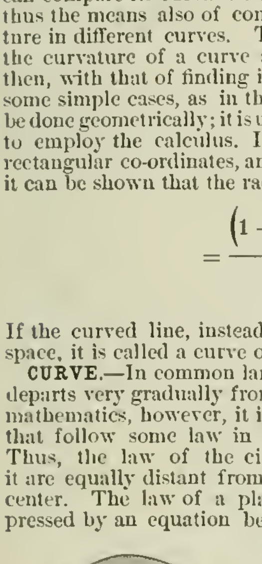
CURTALL.—An ancient piece of ordnance, peculiar for its shortness. Sometimes written *Curtald*.

CURVATURE.—The curvature of a plane curve at a point is its tendency to depart from a tangent to the curve at that point. In the circle this tendency is the same throughout, for the curve is perfectly symmetrical round its center; in other words, the curvature of a circle is constant. In different circles the curvature is inversely as the radius—i.e., it diminishes as the radius increases. The reciprocal of the radius is accordingly assumed as the measure of curvature of a circle. A straight line which has no curvature may be considered part of a circle whose radius equals infinity as the reciprocal of infinity, measures the curvature, and is $= 0$. The constancy of curvature in the circle suggests an absolute measure of curvature at any point in any other curve; for whatever be the curvature at that point, we can always find a circle of the same curvature. The radius of the circle which has the same curvature at any point in a curve as the curve itself at that point is called the radius of curvature of the curve for that point; and the circle itself is called the *osculating* circle. If we know the radius of curvature of a curve at different points, we can compare its curvature at those points. We have thus the means also of comparing degrees of curvature in different curves. The problem of measuring the curvature of a curve at any point is the same, then, with that of finding its radius of curvature. In some simple cases, as in the conic sections, this may be done geometrically; it is usually necessary, however, to employ the calculus. If the curve be referred to rectangular co-ordinates, and x, y be a point in it, then it can be shown that the radius of curvature

$$= \frac{\left(1+\frac{dy^2}{dx^2}\right)^{\frac{3}{2}}}{\frac{d^2y}{dx^2}}.$$

If the curved line, instead of being plane, twists in space, it is called a curve of double curvature.

CURVE.—In common language, a crooked line that departs very gradually from the straight direction; in mathematics, however, it is usually restricted to lines that follow some law in their change of direction. Thus, the law of the circle is that all points of it are equally distant from a fixed point, called the center. The law of a plane curve is generally expressed by an equation between the co-ordinates of any point in it referred to a fixed point. When the equation of a curve contains only powers of x and y, the curve is algebraic; when the equation contains other functions, logarithms for instance, of x and y, the curve is called transcendental. The cycloid, e.g., is a transcendental curve.



There are also curves, like the spiral, that do not continue in one plane; these are called curves of double curvature. To express the law of such a curve requires three co ordinates and two equations. Curves are said to be of the first, second, third, etc., order, according as their equations involve the first, second, third powers of x or y. The circle, ellipse, parabola, and hyperbola are of the second order of curves. There is only one line of the first order, namely, the straight line, which is also reckoned amond the curves. The higher geometry investigates the amount of curvature of curves, their length, the surface they inclose, etc.

The number of curves that might be drawn is, of course, infinite. Quite a large number have received names, and are objects of great interest to the mathematician—in some cases, for their beauty; in others, for their remarkable properties. Among the most interesting are the following: 1, circle; 2, ellipse; 3, hyperbola; 4, parabola; 5, cissoid of Diocles; 6, conchoid of Nicomedes; 7, lemniscata; 8, cycloid; 9, harmonic curve; 10, trochoid; 11, the witch; 12, cardiode, 13, curves of circular functions—e.g., curve of sines; 14, the logarithmic curve; 15, the spiral of Archimedes; 16, the catenary; 17, the tractory; 18, the tractrix; 19, the ovals of Cassini; 20, the reciprocal spiral.

The term *curve* is also applied to a draughtsman's instrument having one or a variety of curves of various characters other than arcs, which may be struck by a compass. Such a combination of curves is shown in the drawing. They are frequently constructed for specific purposes, such as *shipwright's curves, radii-curves*, etc.

CURVED FIRE.—When a projectile is fired so as just to clear an interposing cover, and then descend upon the object, the line of fire being perpendicular or nearly so to the front of troops or works to be destroyed, such practice is termed *curved fire* in order to distinguish it from ricochet. This kind of fire has been long employed to dislodge troops posted behind cover by firing common shells from guns or howitzers. Smaller charges and higher angles would, as in ricochet, be required than for ordinary direct fire. The employment of curved fire at the siege of Strasburg by the Prussians, during the Franco-Prussian War, was very successful, a hidden escarp at a range of 910 yards having been breached with a 6-inch B. L. R. gun, with a charge of powder $\frac{1}{10}$ the weight of the projectile fired, which was 60 lbs. Under curved fire it is necessary that a projectile should strike the revetment at a considerable angle of descent, with sufficient energy to destroy the masonry. Now, in order that a considerable angle of descent may be obtained at a moderate range (from 1000 to 1500 yards) it is necessary that the remaining velocity should be low; and this may be obtained in two ways —by a projectile that has been fired originally with a comparatively high velocity, and has lost it rapidly; or by a projectile that has been fired originally with a lower velocity and a higher elevation, but has not lost its velocity so quickly. If the projectile has the same weight in both cases, the first result would be obtained by a short shell of large caliber, the second by a long shell of smaller caliber, the resistance of the air having a greater effect on the former than the latter. The question is, which of the two systems would be preferable ?

CURVE OF RESISTANCE.—When the velocities of a projectile at two points in the trajectory near together are known, the amount of resistance, R, offered by the air at the mean velocity can be formed from the formula $R = \frac{w(v^2 - v'^2)}{2gS}$; in which $w =$ weight of the projectile; v and $v' =$ the velocities at the two points; and $S =$ the space in which the velocity is reduced from v to v'. If several resistances are determined in this manner from velocities obtained in practice, a *curve of resistance*, which will give the resistances at all intermediate velocities, may be constructed.

CUSHMAN COMBINATION-CHUCK.—A variety of chuck much employed in the armory and ordnance-shops. The drawings show the construction and action of the device. That portion of the jaws which enters the body of the chuck is cut into a half nut (A, Fig. 3) that engages with a screw (B), the square head of which projects through the face or rim of the chuck to receive a wrench. Below this projecting head is a bevel pinion inside the rim that engages with a circular rack or toothed ring (C C). Turning any one of these screws will actuate the rack and every other screw, and so far it is simply a concentric-jawed chuck. The toothed ring rests upon a plain ring (D D), the periphery of which is a screw-thread that engages with a similar thread on the inside of the shell, so that by turning the ring in one direction it is moved forward towards the face of the chuck, and by turning it the other way it is carried towards the back of the chuck. By this means the circular rack may be meshed in gear with the pinions on the screws, or disengaged from them (Figs. 1 and 2). When in and out of gear the ring (D D) is held in position by a spring catch. Should it be required to move one or more of the jaws further from the center than the others, the spring catch is released by thumb-pressure, the supporting ring is turned out by a knob at the back of the chuck, and the circular rack unmeshed. In this condition it has the characteristics of an independent jaw-chuck. See *Chuck*.

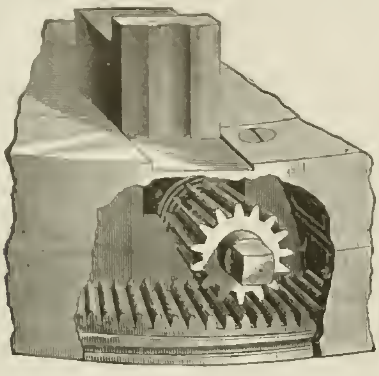


Fig. 1.

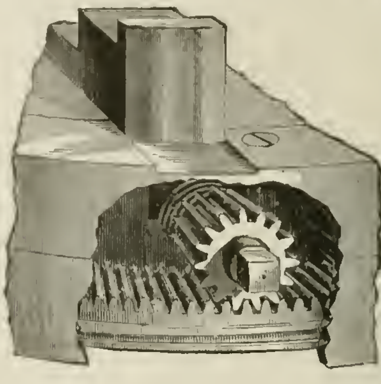


Fig. 2.

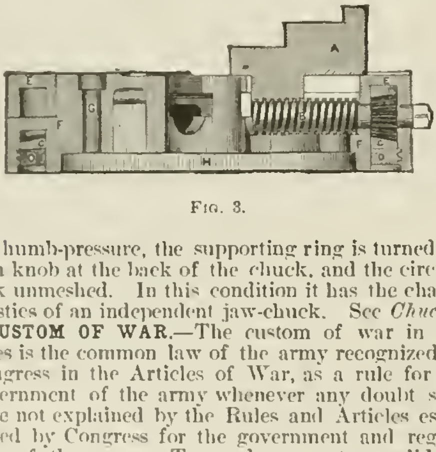


Fig. 3.

CUSTOM OF WAR.—The custom of war in like cases is the common law of the army recognized by Congress in the Articles of War, as a rule for the government of the army whenever any doubt shall arise not explained by the Rules and Articles established by Congress for the government and regulation of the army. To render a custom valid the following qualities are requisite: 1. Antiquity; 2. Continuance without interruption; 3. Have been acquiesced in without dispute; 4. It must be reasonable; 5. Certain; 6. *Compulsory*—that is, not left to the option of every man whether he will use it or not; 7. Customs must be consistent with each other.

CUT.—A term employed in mechanical maneuvers signifying to move the object horizontally, without rolling, by moving each end alternately in the required direction. See *Cuts* and *Mechanical Maneuvers*.

CUT-AND-THRUST SWORD.—An ancient offensive weapon used for cutting and thrusting. It was straight-bladed, at first short and broad, afterwards longer and double-edged, sharp pointed, with a rectangular sheath, and always worn on the right side.

CUTLASS.—A short, heavy, curving sword; especially used by seamen in boarding or repelling boarders. The term is abbreviated from *curtal-axe*. Rosalind calls it a *curtle-axe*. It is usually about 3 feet long, with a japanned hilt.

CUT OFF.—In a military sense, this phrase is variously applicable. *To cut off an enemy's retreat* is to maneuver in such a manner as to prevent an opposing army or body of men from retiring when closely pressed either to their intrenchments or into a fortified town from which they had marched or sallied.

CUTS.—1. Movements in saber-exercise, executed as follows:

Front Cut.—Being at guard, raise the saber, the arm half extended, the hand in front of the right shoulder, and a little higher than the head, the edge upward, the point to the rear, and higher than the hand. (Two.) Cut, extending the arm to its full length. (Three.) Resume the guard. The first position of *front cut* is the position of *raise saber*.

Left Cut.—Being at guard, turn the head and shoulders to the left, raise the saber, the arm extended to the right, the hand in quarte and as high as the head, the point higher than the hand. (Two.) Cut diagonally to the left. (Three.) Resume the guard.

Right Cut.—Being at guard, turn the head to the right, carry the hand opposite the left breast, the point of the saber upward, the edge to the left. (Two.) Extend the arm quickly to its full length, and give a back-handed cut horizontally. (Three.) Resume the guard. The *left* and *right cuts* are used against infantry, inclining the body forward, and cutting at the necessary angle.

Rear Cut.—Being at guard, throw the right shoulder well back, and execute the first motion of *right cut*. (Two.) Extend the arm quickly to its full length, and give a back-handed cut horizontally to the rear. (Three.) Resume the guard.

Left in Quarte and Tierce Cut.—Being at guard, execute the first motion of *left cut*. (Two.) Execute the second motion of *left cut*. (Three.) Turn the hand in tierce and cut horizontally. (Four.) Resume the guard.

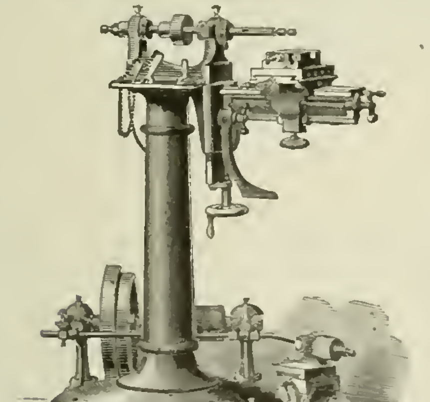
Right in Tierce and Quarte Cut.—Being at guard, execute the first motion of *right cut*. (Two.) Execute the second motion of *right cut*. (Three.) Turn the hand in quarte, and cut horizontally. (Four.) Resume the guard.

Rear in Tierce and Quarte Cut.—Being at guard, execute the first motion of *rear cut*. (Two.) Execute the second motion of *rear cut*. (Three.) Turn the hand in quarte, and cut horizontally. (Four.) Resume the guard. See *Saber-exercise*.

2. When breaching walls, it is necessary to separate that part of the masonry or revetment to be overthrown from the adjoining portion, in such a manner that it may soon be brought down by its own weight and by the fire directed upon it. The best method of effecting this is to cut the wall first in a horizontal direction, and then vertically at such distances as the strength of the masonry may require. In general, the height of the horizontal cut should be about one third the total height of the scarp-wall from the bottom, though in some cases it may be preferable to make it as high as the middle line of this wall. This will depend greatly upon the thickness of the wall, and should be determined in each case at such a height that the breach may be practicable. If too

high, the ramp composed of the débris will be intercepted by a portion of the wall; if too low, the opening will be masked by the débris itself. The length of the cut will be regulated by the width of passage required for the assaulting party, generally from 20 to 30 yards. Each gun has a certain space allotted to it, and commences firing at one extremity, spacing the shots at regular intervals depending upon the caliber of the gun. Returning, it fires at points exactly between the former, and finishes by destroying any salient parts of the masonry left uninjured throughout the line. The completion of the cut will be known by the earth falling through. By marking on the platform the direction of the stock and wheels at each fire, on returning the proper direction can easily be given to the piece. The elevation will remain unchanged. The number of vertical cuts having been determined so that no section of the wall shall be sustained by more than one counterfort, the cuts are formed by first firing a shot at a certain distance above the horizontal line and then another in the center of this interval; the intermediate salient points are destroyed as before. A second equal length of cutting is effected in the same manner, and so on until the length is sufficient. Care must be taken that the extreme vertical cuts progress as rapidly as the others. These vertical cuttings need not, in general, be carried to a greater height than one half the distance between the horizontal line and the cordon, nor is it always necessary that they should penetrate quite through the revetment as in the case of the horizontal cut. If the wall does not fall on the completion of the cuts, a few volleys are fired at the middle of the spaces thus outlined. After the wall has fallen, the counterforts are battered down, and, if necessary, the fire continued upon the backing of earth in order to make the slope easy of ascent. See *Breaching*.

CUTTER-GRINDER.—A grindstone or emery-wheel specially constructed for grinding the sections of cutter-bars. In the machine commonly employed in the United States arsenals, the platen to which the holder and guide are attached is adjusted in height to suit the diameter of the cutter to be operated upon. The guide rests against the tooth that is being ground, thus gauging the work perfectly, even though there may be irregularity in the size of the teeth. The machine is adapted to cutters of all sizes and styles of teeth, whether straight, beveled, or spiral. Either small grindstones or emery-wheels may be attached to the spindle.



The drawing shows a very efficient machine of this class, made by E. E. Garvin and Company. The construction has been simplified by substituting a planed knee for the heavy stud in former use. A sliding platform, made to move more freely than in the old-style machine, is fitted to this knee and is bound in any desired position by tightening a gib by means of a hand-screw shown beneath. A special attachment is also provided for this machine when required for surface-grinding. The drawing shows it in position on the machine, with the cutter grinding-head on the floor. The machine can be changed from a cutter-grinder to a surface-grinder in a few minutes. Upon the sliding platform is a stand capable of being held by a cam binder at any desired angle. This stand is used for the mandrel-stud, and has a graduated arc of 90 degrees for setting the stud at any angle. The centers shown in the drawing enable the operator to sharpen reamers and taps of almost any shape. With this machine all sizes and shapes of cutters can be handled from ½ inch to 8½ inches diameter, and face mills, by using platform shown at foot of machine, up to 12 inches diameter. The arrangement is such that plenty of space is allowed for the hands in sliding the work upon the mandrel. The slide and spindle bearings are sheathed and covered with cap-nuts for the exclusion of dust and emery. The spindle-boxes have adjustment for wear, and the sliding surfaces are substantially gibbed. The surface-grinder will grind a piece 10 inches long and 8 inches wide. The slide is operated by a rack and pinion movement, making it very sensitive and quickly handled. The cross-feed is operated by a screw attached to the end of the knee. This attachment is very useful in grinding small hardened work, such as straight edges, cutting dies, calipers, gauges, etc. Small pieces can be held in a vise made fast to the slide for that purpose. The countershaft-hangers are adjustable and self-oiling. The following are the general dimensions:

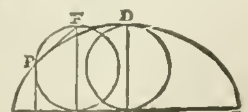
Tight and loose pulleys on countershaft 4½ by 2 in. face
Speed of countershaft ....400 rev.
Weight of machine, complete..............300 lbs.

CUTTING-OFF MACHINE.—This most useful machine is essential to the proper equipment of the foundry, arsenal, and other places where shafts, rods, bars, or pipes are to be cut to length. Cutting off constitutes a large share of the blacksmith-work of a machine-shop, and when performed in the usual manner costs three times as much as if done by a machine. The ordinary mode of cutting off consists of three operations—heating, cutting with chisels, and finishing the ends afterwards; either of these operations costs as much as to cut off by a machine which performs all at once. The Betts machine can be operated by unskilled workmen, and can be set in an iron-room to save space in the machine-shop; the tools require no dressing, and can be ground by any one. Such a machine can be profitably employed where five or more machinists are at work, and is found to be a very important machine tool. The angle and movement of the tools are wholly different from those of a lathe, which cannot be used to advantage for such work; the tools have uniform section, and are supported to the end at their bottom edge in a special tool-clamp, having a new adjustment to alter the angle of the cutting edge of the tool, in operating on soft or hard material. In rolling-mills and iron-works, where large numbers of pieces are to be cut, one attendant can operate two machines if both are arranged with power-feed.

CUTTING-SHOE.—A horseshoe with nails on only one side, for horses that *cut* or *interfere*. See *Horseshoeing*.

CYANE.—An ancient metallic composition used for the ornamentation of cuirasses and for the embellishment of the bosses of shields.

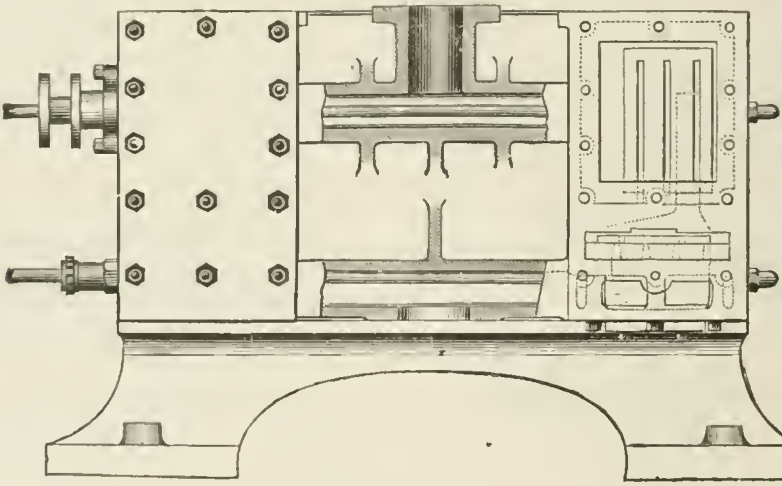
CYCLOID.—If a circle roll along a straight line on its own plane, a point on the circumference describes a curve which is called the cycloid. The curve is one of the most interesting we know in respect both of its geometri-



cal properties and connection with dynamics. One of its most interesting properties is this: The time of a body's descending from rest from any point in the arc of an inverted cycloid to the lowest point is the same, from whatever point of the curve the body begins to descend. This is sometimes expressed by saying that the cycloid is the *isochronous curve.* The body having reached the lowest point will, through the impetus received in the fall, ascend the opposite branch of the curve to a height equal to that from which it fell, losing velocity in its ascent by the same degrees as those by which it acquired it in its descent, and it will employ precisely the same time in ascending as it did in descending. It is clear that if a surface could be procured that would be perfectly smooth and hard, the cycloid would thus present a solution of the problem of perpetual motion. The curve was discovered by Galileo in 1615.

CYLINDER.—1. The name of a genus of geometrical solid figures, of which there may be an endless species. The most common kind of cylinder is that which is generated by the revolution of a rectangular parallelogram about one of its sides, which line is called the axis of the cylinder. But in order to embrace all varieties of cylinders, we must generalize the mode of generation. A cylinder, then, is a solid generated by a line which moves parallel to itself while one end traces upon a plane any curve whatever. When the position of the generating line is at right angles to the plane, the cylinder is *right;* when not, it is *oblique.* If the curve traced is a circle, and the line perpendicular to the plane, the cylinder is a *right circular cylinder*, etc. In all cases the content of the cylinder is found by multiplying the number of square units in the base by the number of linear units in the altitude, which is the perpendicular distance between the two ends. The area of the convex surface is equal to a rectangular parallelogram whose base is the circumference of the end, and its height the length of the generating line. To this must be added the areas of the two ends, to get the entire surface of the cylinder.

2. That chamber of a steam-engine in which the force of steam is utilized upon the piston. The cylinder is generally designed to meet the requirements of the valve-construction. The drawing shows an elevation of the Cummer cylinder, in which is seen, in part section, the steam-passage with a short length of pipe, and below it the exhaust-passage. On either side are the steam- and exhaust-chests; that on the right has the cover removed, showing steam- and exhaust-valves. The valve-stems are also shown; they pass through the steam- and exhaust-passages and connect the valves at one end with those at the other. The exhaust valve-seat is removable for greater convenience of construction, and to allow for refacing. Below the exhaust-valve is the exhaust-passage. The steam enters the cylinder through a three-ported seat, afterwards uniting to form but one opening into the cylinder, and is exhausted through the lower part of this same port, which then by one large opening communicates with the chest in which the exhaust-valve is located. There is no real connection between the two, however; each valve within its own chest controls its own ports, and live steam cannot enter the exhaust. The valves are carefully scraped to an accurate bearing, and being flat are easily fitted and remain tight for a long time. Both steam- and exhaust-valves have a constant travel under all conditions, and this conduces to equal wear, while from the simple construction, whenever repairs are needed, they may be easily made in an ordinary shop with ordinary tools. This is a very desirable point. The valve and valve-stems as well, as the eccentrics, are provided with means of adjustment so that the desired amount of lead and cut-off may be given the steam-valves, and the exhaust-valves set for the desired release and degree of compression. Each valve can be adjusted independently of the others so as to act in the most efficient manner. See *Steam-engine.*



Cummer Cylinder.

CYLINDER-GAUGE.—An instrument employed in the inspection of cannon. It is a hollow cylinder of iron, turned to the least allowed diameter of the bore, and one caliber in length. It has a cross-head at each end, one of which has a smooth hole through its axis to fit the staff, and the other is tapped to receive the screw in the end of it. The cylinder-gauge is introduced into the bore of the gun, and must pass freely to the bottom of the bore. The instrument shows that the bore is not too small. See *Inspection of Ordnance.*

CYLINDER-MILL.—One form of a mill for pulverizing the ingredients of gunpowder, having a cylindrical runner traversing on a bed-stone. See *Gunpowder.*

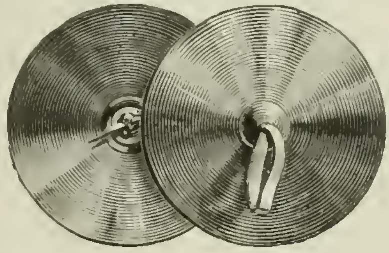
CYLINDER-POWDER.—That of which the charcoal is made in iron cylinders. See *Gunpowder.*

CYLINDER-STAFF.—An instrument used, in the inspection of ordnance, to measure the length of the bore. It is supported by a rest of a T-form at the muzzle, and the extremity inserted in the gun is armed with a *measuring-point* and a *guide-plate.*

CYLINDRICAL CHAMBER.—In the 8-inch siege-mortar, and in the eprouvette-mortar, the bottom of the bore at the mouth of the chamber is formed of a portion of a sphere, so that the projectile closes the mouth of the chamber. In other howitzers the chamber is connected by means of a conical surface, the junctions being rounded off to prevent being worn away by the action of the powder. Cylindrical chambers when narrow and deep give greater ranges than shallow wide ones, which do not confine the powder so much; but as in the former the gas acts on but a small segment of the projectile (usually hollow), it sometimes breaks it; and for this reason too great a depth in cylindrical chamber must be avoided.

CYLINDRICAL INCH.—A term employed in ordnance. It is a cylinder whose base is one inch in diameter and whose altitude is one inch.

CYMBALS.—Military instruments of percussion, which, when struck one against the other, produce a loud harsh sound of no fixed pitch. The best cymbals are those made in Turkey and in China. Attempts to discover and imitate the composition of the metal have all failed. The notes in music for this instrument are all placed on the same line or space, in rhythmical succession. Cymbals, although military instruments, are now much used in the orchestra by modern composers. Cymbals are among the most ancient instruments, being represented in different forms upon the sepulchral monuments. They were used by the Levites in the Temple Ordinances, and the sons of Asaph excelled in their use. They are



mentioned among other instruments, 1043 B.C., when David brought the ark home,—*harps, psalteries, timbrels, cornets, cymbals* (2 Sam. vi. 5). The *loud-sounding* and *high-sounding* cymbals mentioned in Psalms cl. 5 were probably the clashing cymbals and rattling castanets. See *Band.*

D

DAG.—A thick clumsy pistol used in the fifteenth and sixteenth centuries. In the *Spanish Tragedy*, published in 1603, one of the characters shoots the dag.

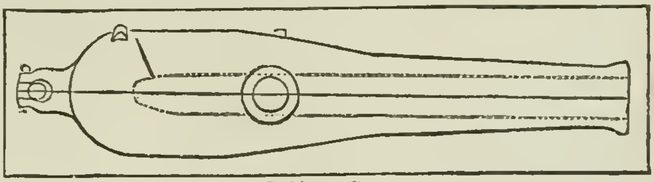
DAGEN.—A peculiar kind of poniard used in very ancient times. Now obsolete.

DAGGER.—A weapon resembling a sword, but considerably smaller, being used for stabbing at close quarters. Daggers are generally two-edged, and very sharp towards the point. Originally it had no guard for the hand, and was worn at the girdle in a sheath. It is now regarded as a general military weapon in European countries. The dagger was a part of the equipment of the Frank warrior, who probably called it a *coutel*, or something like that. It does not differ materially from the *dirk* of the Gadhelic branches of the Celts, or the *poniard* of the nations who acknowledge Latin as the base of their mother-tongues. In the fourteenth century it was carried by citizens, yeomen, sailors, and ladies. It survives in England in the midshipman's *dirk*, and in other places as a *stiletto*, a *bowie-knife*, etc. Some ingenuity has been expended on this weapon in the mode of attaching it to the handle and providing the latter with a pistol.

DAGUE.—A short thick poniard which was formerly much used when individuals engaged in single combat.

DAHLGREN BREECH-STRAP.—A strap connecting the breech with a separate trunnion-ring, in order to avoid longitudinal weakness in a gun, without disturbing the usual and convenient preponderance. The strap is made of bronze, and cast in two pieces: one piece constituting the strap, half the trunnion-ring, and the greater part of the trunnions; the other constituting the opposite half of the trunnion-ring and the remainder of the trunnions. The two parts are riveted together at the trunnions. This strap remedies another and greater defect of cast-iron guns than longitudinal weakness—the unsoundness of the casting around the trunnions.

DAHLGREN GUN.—The Dahlgren guns of large caliber are made of cast-iron, solid, and cooled from the exterior. To produce uniformity in the cooling, the piece is cast nearly cylindrical, and then turned down to the required shape, which is shown in the drawing. The thickness of metal around the seat of the charge is a little more than the diameter of the bore, which rule holds good for nearly all cast-iron guns. The chase, however, tapers more rapidly than in other cast-iron guns, which gives the appearance of greater thickness of metal at the reinforce.



Dahlgren Gun.

The chamber is of the Gomer form. The principal guns of this system are of 9- and 11-inch caliber. A piece of 10-inch caliber has, however, been introduced into the Navy, on Admiral Dahlgren's plan, for firing solid shot with 40 lbs. of powder. The 15-inch and 20-inch naval guns are shaped exteriorly after the Dahlgren pattern, but are cast hollow and have the elliptical chamber of the Rodman system. The following table shows the principal dimensions, etc., of Dahlgren guns:

Gun.	Length of Bore.	Maximum D m.	Weight.	Service-charge.	Maximum Charge.	Weight of Shot.	Weight of Shell.
	Inch.	Inch.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.
20-inch	163	64	100,000	100		1,080	
15-inch	130	48	42,000	35	60	400	330
13-inch	130	41.7	36,000	40		280	224
11-inch.	132	32	16,000	15	20	170	130
10-inch.	119¼	29.1	12,000	12¼	16	125	100
9-inch.	107	22.2	9,200	10	13	93	70
125-pdr..	117¾	33.25	16,500	40		125	100

See *Cast-iron Guns* and *Ordnance.*

DAM.—A barrier for raising the level of water in a stream, for the purpose of forming a reservoir, inundating, or for turning the water in another direction. Several dams are sometimes placed upon a water-course for the purpose of preventing too rapid an escape of water where it is needed for irrigation or for moving machinery. There is also a variety of dam called a coffer-dam, in which an inclosure is bounded by a barrier which prevents exterior water from entering, used generally for the purpose of excavation. Dams constructed for raising the level of water have an important use in the slack-water navigation of rivers. The materials which enter into the construction of dams differ according to circumstances. If the structure be required to bar a narrow gorge and a considerable stream, it must be made very strong, not only to withstand the hydrostatic pressure, but also the force of the current, which often, during freshets, becomes very great. The materials are then generally composed of a combination of wood-work and masonry. Masonry may be principally used when the gorge is so narrow as to allow of the construction of a sufficiently small horizontal arc to resist the pressure. When the dam is very long (across a wide stream), unless a vast amount of stone is used, wooden braces must be employed. When the body of water to be restrained is not more than four or five feet deep and the bottom is firm, a clay or stiff loam embankment nine or ten feet thick, well compacted, will answer the purpose if a gate be provided to keep the water from flowing over the top of the embankment, which would cause it to wear away. It is not always economy to build the dam in the narrowest part of the stream, or where the opposite banks nearest approach each other. This will often cause, during a freshet, too great a depth of running water over the dam, by which it may be endangered. A point should be selected where the dam can be made of sufficient width to allow the water to pour over it without piling up too much, and where the foundation is good. The line of a dam may be transverse or diagonal to the flow of water. The diagonal is sometimes of advantage in increasing the width of flow, but is liable to interfere with the bed of the stream below more than the transverse line. Where practicable, the form of an arc, the convexity fronting up stream, is the best; but a broken line may sometimes be employed to advantage, the angles pointing up stream acting as braces, while the angles pointing down stream may be held by natural rock-formation or heavy masonry strengthened by bracing.

DAMAGES.—The costs of repairs of *damage* done to arms, equipments, or implements, in the use of the armies of the United States, are to be deducted from the pay of any officer or soldier in whose care or use the said arms, equipments, or implements were when the said damages occurred: provided, the damage was occasioned by the abuse or negligence of said officer or soldier. Every officer commanding a regiment, corps, garrison, or detachment is required to make once every three months, or oftener if required, a written report to the Chief of Ordnance stating all damages to arms so belonging to his command, and naming the officers and soldiers by whose negligence or abuse the damages were occasioned.

Barrack damages, in the British army, is the term applied to injuries done to barracks, barrack-furniture, etc., by soldiers, when the actual perpetrator cannot be discovered.

DAMASCENING—DAMASKEENING.—The art of producing upon ordinary steel certain ornamental appearances resembling those observed on the famous Damascus blades. Attention was first drawn to this branch of industry by the Crusaders, who brought from Damascus to Europe many articles made of superior steel, such as sword-blades and daggers. These were found to possess not only great elasticity, united with considerable hardness, but their surfaces were covered with beautiful designs, formed by a tissue of dark lines on a light ground, or light lines upon a dark ground, and occasionally by the inlaying of gold on the steel-blue ground. These Damascus blades appear to have been constructed of steel and iron welded together; and the elegant designs were brought out by immersing the blades in dilute acids, which, eating away unequally the surface, gave rise to the mottled appearance. In genuine Damascus blades the designs run through the substance of the blade, and the watering, or regular, almost symmetrical figuring, is not worn off by friction, or even grinding. Imitations of the watering of Damascus steel are produced on common steel by etching with acids; and in this way landscapes, inscriptions, and ornaments, and decorations in general, are imprinted on the steel-blue ground. Gold and silver are also inlaid in the higher class of sword-blades and other articles. Gun-barrels are occasionally subjected to the process of damascening. Attempts have been lately made in France to accomplish damascening by means of photography, but as yet with very imperfect results.

DAMASKIN.—A certain variety of saber; so called from the manufacture of Damascus.

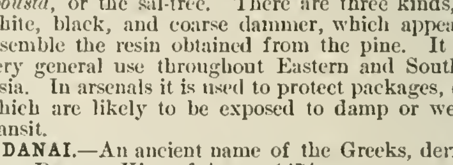
DAME.—Among miners, any portion of the earth which may remain after the explosion of a mine has taken place. It likewise means a piece of wood with two handles used to press down turf or dirt in a mortar.

DAMMER.—A resinous substance found in many parts of India; it exudes from different kinds of trees. That used in Bengal is yielded by the *Shorea robusta*, or the sâl-tree. There are three kinds, the white, black, and coarse dammer, which appear to resemble the resin obtained from the pine. It is in very general use throughout Eastern and Southern Asia. In arsenals it is used to protect packages, etc., which are likely to be exposed to damp or wet in transit.

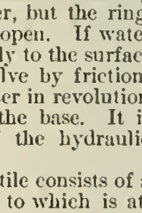
DANAI.—An ancient name of the Greeks, derived from Danaus, King of Argos, 1474 B.C.

DANAIDE.—An hydraulic machine made of two cylinders, one within the other, turning easily on a vertical axis, and having a small space between them. The smaller one is closed at the bottom, and the other has a hole in the middle of its base. The bottoms of the two are separated by partitions reaching from the circumference to the center, but the ring-like space between the cylinders is open. If water be turned into this space horizontally to the surface of the cylinders, they begin to revolve by friction, which motion is increased by the water in revolution acting on the radial partitions in the base. It is found that nearly three quarters of the hydraulic power can thus be utilized.

DANA PROJECTILE.—This projectile consists of a cast-iron body having a conical base, to which is attached a cup-shaped ring of brass. Upon discharge,



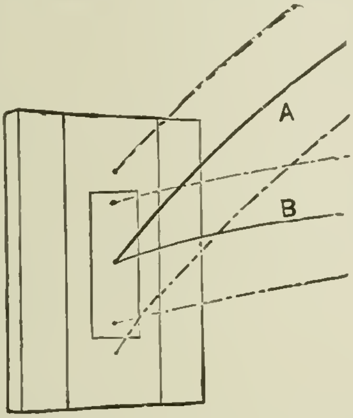
the ring is driven forward upon the base, and by this movement the soft metal expanded into the grooves and rotation communicated to the projectile. As the front end of the sabot passes the shoulder it is crowded down into the groove cut round the body of the shot, and thus "clinched," as it were. The same end is sought in the arrangement at the bottom of the sabot, where the gas, acting in the cannelure, presses the lip into the groove cut in the cast-iron. Such is the provision designed to secure the sabot from stripping. Turning upon the projectile is prevented by wedge-shaped projections and recesses upon the base of the projectile and the under surface of the sabot. See *Expanding Projectiles.*



Dancette.

DANCETTE.—One of the lines of partition in Heraldry, which differs from indented only in the greater size of the notches. The indentations where the division is *per fess* dancette never exceed three in number. See *Heraldry.*

DANGEROUS SPACE.—That zone, partly before and partly beyond the object fired at (the sights having been correctly elevated), which is *covered* by the trajectory. The object may be displaced to the front or rear of its correct range-point a distance equal, in the aggregate, to the depth of this zone, and still be hit by the projectile. The *dangerous space* will, of course, be increased by the firer lying down and aiming at his adversary's feet. A part of the *dangerous space* is near the muzzle of the gun in the rising branch of the trajectory; the rest of it is in the falling branch. These two parts are continuous up to and including the *battle-range*. The *dangerous space* varies considerably with the weapon used. It is readily seen in the drawing how, with



an equal divergence of the bullets in both cases, those having flat trajectories hit the target, while those having highly-curved trajectories miss it, the one striking above and the other below it. It also varies with the object fired at, and for the same arm diminishes as the range increases beyond *battle-range;* up to this point it increases with the range.

The *dangerous spaces* corresponding to different distances are generally for a height of 63 inches for a foot-soldier and 8 feet 2½ inches for a mounted man. The following table shows the *dangerous spaces* for both a foot-soldier and a cavalryman, corresponding to the different graduations of the rear sights of the muskets of different nations:

DANIELL BATTERY.—A constant battery, much used in mining operations. The containing vessel of the Daniell cell is of copper, which serves likewise as the negative element of the pair. Inside of this is another vessel of porous unglazed earthenware containing a rod of zinc. The space between the copper and the porous cell is filled with a solution of the sulphate of copper, which is kept concentrated by crystals of the salt lying on a projecting shelf, near the surface of the solution, and dilute sulphuric acid is placed with the zinc in the porous cell. When a tangent galvanometer is included in the circuit, the needle keeps steadily at the same point for hours. The rationale of its action is given as follows: The porous cell which keeps the fluids from mingling does not hinder the passage of the current; when the atoms of hydrogen that would ultimately be freed at the copper reach the porous cell, they displace the copper in the sulphate of copper, and copper instead of hydrogen is thrown on the copper plate. To give a graphic representation of this action, it is necessary to suppose that the sulphate of copper is $CuSO_4$, the direct combination of the metal (Cu) with a salt radical (SO_4) called sulphion, and that the dissolution of the zinc arises from the decomposition of sulphuric acid, regarded as the sulphionide of hydrogen (H_2SO_4), the SO_4 directly attacking the metal. This view of the composition of oxygen salts, though new in Daniell's time, is now universally admitted. Taking these letters to represent the molecules, and beginning with the copper (Cu) of the outer vessel, and ending with the zinc (Zn) of the rod, we have the arrangement before discharge, $Cu,\overline{CuSO_4}.\overline{CuSO_4}.^{cl}\overline{H_2SO_4}\ \overline{H_2SO_4}\ Zn$; and after it, $\overline{CuCu}\ \overline{SO_4Cu}\ \overline{SO_4}^{cl}H\ \overline{SO_4},H\ \overline{SO_4Zn}$. The discharge, therefore, effects a deposition of copper at the copper, and the formation of sulphionide of hydrogen at the porous cell, and of sulphionide of zinc at the zinc rod. Instead of hydrogen in its nascent state being deposited at the copper, we have copper in the same condition; but the galvanic polarization caused by the latter is very much inferior to that resulting from the former, and hence the superior electro-motive force of Daniell's cell. The porous cell keeps the sulphate of zinc from reaching the copper, and thus obviates another source of diminished force in the one-fluid battery. The sulphate of zinc once formed is itself subjected to the decomposing action of the pile, and zinc is deposited on the copper plate, thus tending to give a zinc-zinc instead of a copper-

FOOT-SOLDIER (63 INCHES).

Distances.	United States.		France.		England.		Austria. Old Cartridge.		Austria. New Cartridge.		Spain.		Holland.		Italy.		Prussia.		Russia.		Switzerland.	
	In front.	In rear.	In front.	In rear.	In front.	In rear.	In front.	In rear.	In front.	In rear.	In front.	In rear.	In front.	In rear.	In front.	In rear.	In front.	In rear.	In front.	In rear.	In front.	In rear.
	Yds.	Yds.	Yds.	Yds.	Yds.	Yds.	Yds.	Yds.	Yds.	Yds.	Yds.	Yds.	Yds.	Yds.	Yds.	Yds.	Yds.	Yds.	Yds.	Yds.	Yds.	Yds.
220 yards	220	69	220	80	220	72	220	69	220	80	220	74	220	72	220	72	220	78	220	75	220	71
330 "	78	49	101	57	87	53	71	46	102	57	89	52	77	48	82	50	97	56	94	53	74	46
440 "	43	36	52	38	50	38	43	34	52	39	48	37	47	36	48	37	51	38	51	38	46	35
550 "	32	29	34	28	34	30	30	25	36	31	32	27	31	27	32	27	34	28	34	30	31	27
660 "	24	21	25	22	26	24	22	20	26	24	23	21	22	21	23	21	25	22	26	23	22	21
770 "	19	18	20	17	21	20	16	15	21	20	19	16	17	16	18	17	20	17	21	19	17	16
880 "	16	15	16	14	17	16	13	12	16	16	15	13	14	13	15	14	16	14	16	15	14	13
990 "	12	12	13	12	14	14	11	10	13	13	12	11	11	11	12	11	13	12	13	12	11	11
1100 "	10	10	10	10	11	11	9	9	11	11	10	9	9	9	10	9	10	10	11	10	9	9

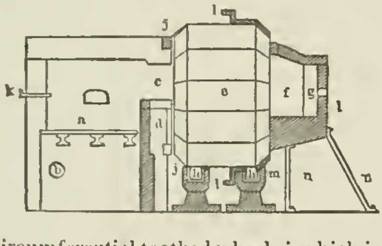
CAVALRYMAN (98½ INCHES).

Distances.	United States.		France.		England.		Austria. Old Cartridge.		Austria. New Cartridge.		Spain.		Holland.		Italy.		Prussia.		Russia.		Switzerland.	
	In front.	In rear.	In front.	In rear.	In front.	In rear.	In front.	In rear.	In front.	In rear.	In front.	In rear.	In front.	In rear.	In front.	In rear.	In front.	In rear.	In front.	In rear.	In front.	In rear.
220 yards	220	112	220	113	220	103	220	98	220	114	220	105	220	101	220	103	220	108	220	107	220	97
330 "	330	76	330	81	330	75	330	68	330	81	330	74	330	72	330	72	330	80	330	77	330	70
440 "	70	57	93	59	84	57	71	50	91	59	84	56	80	54	82	55	91	58	89	57	77	52
550 "	54	43	55	44	55	45	46	38	57	46	50	43	48	42	50	42	54	43	54	45	47	40
660 "	38	34	42	35	43	36	34	30	43	36	38	33	36	32	37	32	40	34	42	36	35	32
770 "	30	28	32	28	33	30	26	23	33	30	30	26	28	25	28	25	31	27	33	30	27	25
880 "	25	24	25	23	26	24	21	19	26	24	23	21	23	21	23	21	24	22	26	24	22	21
990 "	20	18	20	19	21	20	16	15	22	20	19	18	19	17	19	17	20	17	21	20	17	16
1100 "	16	15	15	15	16	16	13	13	17	16	15	14	14	14	14	14	15	15	16	15	14	13

See *Battle-range.*

zinc pair. The constancy of Daniell's battery is not unlimited, for the sulphate of zinc which results from the action, being a bad conductor of electricity, enfeebles the current. In the Daniell cell used for telegraphs, the containing vessel is of glass, and no sulphuric acid is added to the water round the zinc, as, in the course of the action, sufficient acid comes through from the sulphate cell. See *Galvanism*.

DANK ROTARY FURNACE.—In order to lessen the great amount of labor involved in working the charge, various mechanical appliances have been proposed in substitution for manual puddling. They may be generally classified under two heads: namely, those imitating the motions of hand-stirring, and those using rotating or oscillating hearths. The drawing shows Dank's rotary furnace, which has a fire grate, *a*, like an ordinary puddling-furnace, with a blast, *b*, under the grate, and also, *k*, over the fire. The ash-pit and fire-hole are closed. The fire-bridge, *d*, is of iron, and has a water-pipe cast into it to cool it, and a lining of fire-brick next to the fire, and on top, and a covering of *fettling* next to the charge. A ring of hard metal is placed on the bridge-plate for the bearing of the chamber, and forms a butt-joint. The revolving chamber, *e*, is an open-ended cylinder, one end of which butts against the ring on the bridge, where the gases are admitted from the fire at *c;* and the other end serves as a door for the reception and removal of the charges, and also for the escape of the products of combustion. The chamber rests on rollers, *h h*, and



has a circumferential toothed wheel, *i*, which is geared to an engine. The chamber is lined with a mortar of pulverized ore and lime, which is laid on the inside quite thick and dried. The lining is completed by "fettling," which consists in charging a small quantity of fine ore and melting it while the chamber is revolving. When it is melted the revolution is stopped, and the molten metal settles in a pool at the bottom. Small and large lumps of ore are thrown into the pool, which is allowed to solidify. A fresh quantity of fine ore is again charged, and the process repeated, the chamber being stopped at a different place each time. This is continued until the whole chamber is lined with the ore, or "fettled," when it is ready for charging. At the opposite end or front of the furnace is a movable piece, *f g d*, which answers the purpose both of door and flue. It can be moved by means of suitable apparatus overhead, and when in its place the escaping gases pass through at *f* into the flue and chimney. When it is removed for the introduction or removal of the charge, the end of the chamber is open. The operation of the furnace is as follows: A quantity of mill-cinder is first charged, and on this the iron in a molten or heated condition. A partial rotation is given to the furnace from time to time to expose all portions of the charge to the action of the gases. When the whole of the charge is melted, the chamber is revolved once or twice a minute to obtain the most perfect action of the cinder on the iron. After five or ten minutes the iron begins to thicken, and the rotation is stopped. The heat is raised, and the cinder liquefies, and floats over the iron, containing all the impurities of the iron. The cinder is tapped off by the tap-hole, *m*, and the tap-hole closed. The heat is again raised, and the chamber revolved six or eight times a minute, by which means the charge is dashed about violently in the furnace. A high temperature being kept up, and the charge continually turned over, the particles begin to adhere when the rotations are reduced to two or three in a minute, and the ball speedily forms. The props, *n n*, of the movable piece are removed, and the flue and front of the furnace are moved away, and the ball withdrawn and carried to the hammer or squeezer, where it is formed into a *bloom*. See *Furnace*.

DANNEBROG.—An ancient battle-standard of the Danes, bearing the figures of a cross and crown, and alleged to have fallen from heaven at the battle of Volmar, 1219 A.D. Like the palladium, it was supposed to insure victory, but it was twice captured and twice retaken. The Order of the Dannebrog ranks second in the Danish orders of knighthood.

DANNEVIRKE.—A wall of defense against the Franks built by the Danes in 808 A.D., reaching from the North Sea to the Baltic. During the troubles of 1848 the line of the old wall was strongly fortified, but the works were destroyed in 1864.

DARA BOOKA.—A form of kettle-drum of ancient and modern Egypt, and the connecting-link between the *drum* proper and the *tambourine*. It is more generally called *tam-tam*. See *Tom-tom*.

DART.—A missile spear or javelin much in use among the ancients, and yet seen among many of the more barbarous nations. The Caffres of South Africa and the original inhabitants of Australia are very expert in the use of the *assegai*. The darts in use among the ancients were of two kinds, namely, spear-headed (that is, without barbs) and bearded. The former were often attached to a long cord, enabling the thrower to recover his weapon after having thrown it. Dart-heads are usually made of iron, but among savage nations flints, sea shells, fish-bones, and other hard substances have been employed; and among some of the aboriginal inhabitants of Africa and America the dart was merely a sharp-pointed stick, the end of which was carbonized by fire. The weapon is always very simple in its construction, and is usually from 3 to 5 feet long.

DATERAM.—The Bornu name for a most excellent African contrivance, used in some parts of the Sahara Desert, by means of which tent-ropes may be secured or horses picketed in sand of the driest description, as in that of a sand-dune, whence a tent-peg would be drawn out by a strain so slight as to be almost imperceptible. The plan is to tie to the end of the tent-rope or tether a small object of any description by its middle, as a short stick, a stone, a bundle of twigs, or a bag of sand, and to bury it from 1 to 2 feet in the loose sand. It will be found, if it has been buried 1 foot deep, that a strain equal to about 50 pounds weight is necessary to draw it up; if 1½ feet deep, that a much more considerable strain is necessary; and that if 2 feet deep, it is quite impossible for a single man to pull it up. Theoretically this is obvious; for, supposing the earth to consist of smooth, spherical grains of one size, and granting that these grains cannot move horizontally at the moment of drawing, and that they *must* move vertically upwards, it is plain that the substance attached to the rope when moved upwards must start before it an inverted pyramidal pile of grains. Take the most unfavorable case, supposing it to be a triangular pile; then the number of grains to be started (and consequently their weight) varies as $\frac{n(n+1)(n+2)}{1 \,.\, 2 \,.\, 3}$, or in a ratio greater than n^3 (n being the number of layers of grains above). In practice the grains of sand are capable of a small but variable amount of lateral displacement, which gives relief to the movement of sand caused by the *dateram*. On the other hand, the friction of the grains of sand tends to increase the difficulty of movement. Of course the resistance varies under different circumstances; but it is no exaggeration to estimate its increase as seldom less than as the square of the depth.

DAUPHINS.—Ornamental handles on brass guns over the trunnions, so called from their resemblance to the fish of that name.

DAUPHIN'S CROWN.—A circle of gold set round with eight fleurs-de-lis, closed at the top with four dolphins, their tails conjoined in a fleur-de-lis.

DAWK.—A method of traveling in India which consists in posting by palanquin from station to station, or for any distance. The traveler must first purchase a strong palanquin, which he can have for from 40 to 100 rupees (£4 to £10), but which he can always dispose of when his journey has been completed, and generally at a profit. His clothes, together with whatever articles he may not immediately need, are carried in tin boxes or wicker baskets called *pettarahs*, by separate bearers, who precede or accompany the palanquin; whatever he considers necessary, however, he keeps beside himself inside. At all the stages, which are from 9 to 11 miles apart, there are relays of bearers, previously provided by the Postmaster, the usual number for one palanquin being eleven. All arrangements as to cost are made with the Postmaster of each presidency before starting, but the traveler is also expected to give some small sum to his bearers at the end of each stage: eight annas (one shilling) among the entire set of bearers is as much as is expected in the way of gratuity. The horse-dawk, a kind of carriage with seats for four, and capable of being used as a bed in which two can sleep, the baggage being conveyed on the top, set on wheels, and drawn by horses, is in use on the great trunk road from Calcutta to the upper provinces, but has not been established throughout the country generally Frequently written *Dak*.

DAY.—Originally the space of time during which it is light, in opposition to the space of darkness or night; it now more usually denotes a complete alternation of light and darkness. It is the earth's rotation that causes the vicissitude of day and night. The earth being a globe, only one half of it can be in the sun's light at once; to that half it is day, while the other half is in its own shadow, or in night. But by the earth's rotation the several portions of the surface have each their turn of light and of darkness. This happens because the position of the earth is such that the equator is on the whole presented towards the sun; had either pole been towards the sun, that hemisphere would have revolved in continual light, the other in continual darkness. One complete rotation of the earth does not make a day, in the usual sense. If the time is noted when a particular fixed star is exactly south or on the meridian, when the same star comes again to the meridian the next day, the earth has made exactly one rotation, and the time that has elapsed is called a *sidereal day*. This portion of time is always of the same length; for the motion of the earth on its axis is strictly uniform, and is, in fact, the only strictly uniform motion that nature presents us with. Sidereal time, or star-time, from its unvarying uniformity, is much used by astronomers. But the passage of a star across the meridian is not a conspicuous enough event for regulating the movements of men in general. It is not a complete rotation of the earth, but a complete alternation of light and darkness that constitutes their day. This, which is called the *civil* or the *solar* day, is measured between two meridian passages of the sun, and is about four minutes longer than the sidereal day. The cause of the greater length is this: When the earth has made one complete turn, so as to bring the meridian of the place to the same position among the fixed stars as when it was noon the day before, the sun has in the mean time (apparently) moved eastward nearly one degree among the stars, and it takes the earth about four minutes more to move round so as to overtake him. If this eastward motion of the sun were uniform, the length of the solar day would be as simple and as easily determined as that of the sidereal. But the ecliptic or sun's path crosses the earth's equator, and is therefore more oblique to the direction of the earth's rotation at one time than another; and besides, as the earth moves in her orbit with varying speed, the rate of the sun's apparent motion in the ecliptic, which is caused by that of the earth, must also vary. The consequence is that the length of the solar day is constantly fluctuating; and to get a fixed measure of solar time, astronomers have to imagine a sun moving uniformly in the celestial equator, and completing its circuit in the same time as the real sun. The time marked by this imaginary sun is called *mean solar time;* when the imaginary sun is on the meridian, it is *mean noon;* when the real sun is on the meridian, it is *apparent* noon. It is obvious that a sun-dial must show apparent time, while clocks and watches keep mean time. Only in four days of the year do these two kinds of time coincide. In the intervals the sun is always either too fast or too slow; and the difference is called *the equation of time*, because, when added to or subtracted from apparent time, it makes it equal to mean time. The mean solar day is divided into twenty-four hours, the hours into minutes and seconds. A sidereal day, we have seen, is shorter; its exact length is 23 hours, 56 minutes, 4 seconds of mean solar or common time. Astronomers divide the sidereal day also into twenty-four hours, which are of course shorter than common hours. In the course of a civil year of 365 days, the earth turns on its axis 366 times, or there are 366 sidereal days. Astronomers reckon the day as beginning at noon, and count the hours from 1 to 24. The civil day begins at midnight, and the hours are counted in two divisions of twelve each. The ecclesiastical day was reckoned from sunset to sunset. See *International Date-line*.

DAY-BOOK.—In the British service, a sort of private memorandum-book in which the Pay-sergeant enters all details of expenditure other than pay under each man's head. These entries are made at the moment, and afterwards transferred to the ledger.

DAY'S MARCH.—The length of a day's march for troops of any army depends, to a great extent, upon the condition of the roads, the supply of water, forage, etc.; also upon the advantages to be gained over the enemy. Under ordinary circumstances infantry should march from 15 to 20 miles a day, halting about 10 minutes every hour. Cavalry should march about 20 miles a day, and be kept at a walk, halting several times during the day. The march of artillery should be governed by the movements of the arms of the service to which it is assigned for duty.

DEAD-ANGLE.—Any ground over which the defenders' fire may pass, but so high above the assailant that he cannot be injured by it, is called a *dead-space*, or a *dead-angle*. Thus, in a redan or a lunette, if the enemy gets into the ditch, he is safe from any fire coming over the parapet. The ditch in each of these cases has the defect known as a dead-space. It was to remedy these defects, which exist in all works where the angles are all salients, that parts of a work were drawn back, or made to form re-entering angles, for the purpose of arranging lines from which direct fires could be brought to bear upon the ground not defended by the lines adjacent to it.

DEAD-HEAD.—1. An extra length of metal cast on the muzzle-end of a gun in order to contain the dross and porous metal which floats on the sounder metal beneath. When cooled and solid the *dead-head* is cut off. It is called also the *sprue*. 2. The tail-stock of a lathe containing both the *dead-spindle* and *back-center*. See *Lathe*.

DEAD-MARCH.—A piece of solemn music intended to be played as an accompaniment to a funeral procession.

DEAD-PAY.—Pay drawn for dead soldiers, whose names are kept on the rolls, and which is appropriated by dishonest officers.

DEAD-SHOT.—An unerring marksman: one whose scores are always high. The term is frequently applied to the best shot in a company or regiment.

DEAD-SPINDLE.—The non-rotating spindle in the *tail-stock* or *dead-head* of a lathe. See *Lathe*.

DEAN FIELD-GUN.—A 3½-inch bronze muzzle-loading field-piece, constructed on the plan of the 3½-

inch Rodman muzzle-loading rifle, model 1870. It is without preponderance. Its length and weight are very nearly the same as those of the light 12-pounder, and it is adapted to the same carriage. The main peculiarity in its construction consists in the application of Mr. Dean's patent process for condensing and hardening the metal of the bore. The rifling consists of seven lands and grooves each. The lands are .50 inch in width. The grooves are 1.07 inch in width and .075 inch in depth. The twist is uniform, making one turn in 12 feet. The vent is in the normal position, on the top of the gun. The gun was cast solid in a cast-iron flask or "chill" about 3½ inches thick, the interior surface being covered with a slight coating of clay and sand. The metal used consisted of three old bronze 6-pounders furnished by the Ordnance Department and a part of a bronze 12-pounder on hand at the foundry. At the second casting the metal of the rejected piece was returned to the furnace, with the exception of a section reserved for tests, and another part of the 12-pounder was added to supply the deficiency. The weight of the charge of metal was 3364 pounds, the time of melting 1 hour 50 minutes, and time of fusion 1 hour 10 minutes. The gun was removed from the flask 18 hours after casting, and when thoroughly cooled was placed in a lathe and the sinking-head cut off. It was next bored out in a boring-machine to a diameter of 3.37 inches.

To condense the metal of the bore the gun was then inclosed in the iron flask in which it was cast, and was placed in the condensing-machine and firmly secured by heavy iron rods. Six mandrels, varying in diameter from 3.42 inches to 3.50 inches, were used in the operation. These, by means of a hydraulic press of 10-inch bore, were in the order of their size successively forced down the bore of the piece and withdrawn, and the operation was repeated until the most of the resilience of the metal had been overcome and the bore enlarged to very nearly 3.50 inches in diameter. The pressures used varied from 500 to 2400 pounds per square inch—making a total pressure of from 19½ to 94 tons. After condensing the bore the gun was removed to the rifling-machine and rifled, the grooves being planed out to a little less than the required depth. It was then put back in the condensing-machine and the bore still further enlarged by means of an expanding mandrel so constructed as to follow the opposite lands and grooves. On account of a slight error in the width of the rifling-tool, the grooves were left too narrow for the ribs of the mandrel, and consequently the edges of the lands were slightly abraded in the operation. A little grinding with fine emery removed much of the rough edge left upon the lands, but did not wholly restore the smoothness desired. In this connection it should be stated that the condensing process was only applied to the cylindrical portion of the bore, and consequently the metal at the bottom was left in its ordinary condition. The gun was next turned down in lathes to its prescribed exterior dimensions and a copper vent-piece inserted. The following are the principal dimensions of the gun:

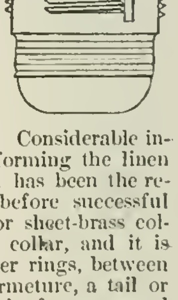
	Inches.
Exterior diameter at the muzzle	6.70
Exterior diameter 62 inches from muzzle (maximum)	11.22
Exterior diameter 65 inches from muzzle	11.05
Diameter of knob of cascabel	3.75
Diameter of trunnions	4.2
Diameter of rimbases	5.68
Length of trunnions, right	3.23
Length of trunnions, left	3.24
Distance between rimbases	11.050
Width of grooves	1.07
Depth of grooves	.075
Width of lands	.5
Twist of rifling	144
Length of bore	65.03
Length of rifling	60.378
Axis of vent from bottom of bore	1.46
Total length of piece	73.86

Weight, 1322 pounds.

See *Bronze Guns* and *Ordnance*.

DEAN MAGAZINE-GUN.—The breech-block of this gun is operated by a small lever, through the intervention of two links, the latter of which causes the recoil-block to descend while the former forces the breech-block to the rear, when the lever is thrown to the front. The lock is of the usual outside pattern and needs no extended description. Two magazines are provided, one in the butt and one in the tip-stock, either of which may be used by locking off, by means of a cut-off, the other. The carrier, which is open at both ends to receive cartridges from either magazine, has a vertical motion at right angles to the axis of the piece. It is operated by the lever in the same general manner as the Winchester repeater, so well known in this country. This gun carries ten cartridges in the tip-stock magazine, six in the butt-stock, and one in the chamber. See *Magazine gun*.

DE BANGE FERMETURE.—This fermeture is noticed at length in the article SCHULTZ WIRE GUN, and only a general description of the mode of checking the escape of gas is intended to be given in this connection. Its general features are shown in the drawing. It recommends itself prominently by effectiveness, its extreme simplicity,



and its not requiring the surface of the bore to be recessed. Its success has warranted its adoption in the land-service of France, and it is applied to all calibers. The gas-check is composed of a fillet or collar made of a linen-cloth disk with a proper-sized circular hole, central with the circumference, set up into the form of a collar to receive its filling. This latter consists of a mixture of two thirds of shredded asbestos and one third of mutton-suet, packed into the collar, which is then closed and completed by a seam formed on the inside surface of the body. Any seams outside would be fatal to the construction. Considerable ingenuity has to be exercised in so forming the linen disk; and the present arrangement has been the result of considerable experiment before successful results were secured. Two zinc or sheet-brass collars cover at top and bottom this collar, and it is placed, in addition with two copper rings, between the rondelle and the face of the fermeture, a tail or rod to the rondelle passing through the fermeture and being keyed to keep the system in position in the block. The vent, lined with copper, finds place in the axis of the breech-block, thus affording central fire. See *Broadwell Ring* and *Schultz Wire Gun*.

DEBLAI.—In fortification, any hollow space or excavation in the ground made during the construction of fortifications or siege-works. The cavity itself is the *deblai*, while the earth taken from it is called the *remblai*.

DEBOUCHING.—In military tactics or evolutions, the marching out of a body of troops from a wood, defile, or other confined spot into open ground.

Debruised.

DEBRIS.—Ruins of a building or town which has been sacked; the broken remains of an army after a defeat.

DEBRUISED.—A term peculiar to English Heraldry, used to indicate the grievous restraint of an animal, and its being debarred of its natural freedom by having any of the ordinaries laid over it. See *Heraldry*.

DECAGON.—In fortification and plane geometry, a figure of ten sides. When the sides are equal, the figure is called a regular decagon. A decagon may be formed from a pentagon by forming any irregular triangles on its sides in such a way that no two of them shall have their sides in the same straight line. A regular decagon is got from a regular pentagon by describing a circle round the latter, bisecting the arcs between its angular points, and drawing lines joining the angular points to the points of section.

DECAMP.—To quit any place or position in an unexpected manner. It likewise signifies to march an army or body of men from the ground where it before lay encamped.

DECANUS.—In Roman military history, a petty officer who presided over the ten soldiers of his contubernium, or those living in the same tent.

DECARBONIZED STEEL.—Since 1873 all small-arm barrels turned out at the National Armory have been made of decarbonized steel (Bessemer), and about one in six hundred only have been found to burst in proof. The principal defects of decarbonized steel as a material for gun-barrels are fine seams running in the direction of the length of the barrel. These seams are sometimes so fine as to escape the numerous inspections to which the barrels are subjected in the course of manufacture, and are only detected by the browning process. Though such barrels have strength to resist the proof-firing, they are rejected for service. A good decarbonized steel for rifle or carbine barrels has sufficient strength to resist a charge composed of one proof-bullet and sufficient musket-powder to fill the bore to the muzzle. A wrought-iron rifle or carbine barrel will only endure about one half of this charge. The breech-loading system after it is finished and assembled to the barrel is subjected to a "finished-proof" charge of a single service-bullet and a charge of 85 grains of musket-powder, which is all that can be crowded into the cartridge-shell. Numerous trials have shown that the Springfield system will stand at least 120 grains of powder and three service-bullets, weighing altogether 1265 grains. The fact that a small-arm barrel seldom or never bursts or swells at the muzzle in proof shows conclusively that when such defects are found in service the cause is some obstruction in the bore. Obstructions arise generally from the improper stopping up of the muzzle to keep out moisture. It may arise from dirt introduced by resting the muzzle of the piece on the ground. Instances have occurred of the bursting of service-barrels by a bullet in the bore—the result of a charge insufficient to expel it. Very accurate and delicate machines are now used to weigh each finished cartridge and reject any that may be deficient in powder. The barrel of a rifle will endure at least 10,000 service-fires before its accuracy is sensibly impaired; and its exterior dimensions may be very much reduced by wear without impairing its strength for service. See *Small-arms* and *Steel*.

DECEASED OFFICERS AND SOLDIERS.—In the United States service, the death of an officer, with cause, date, and place, is reported without delay by his immediate Commander direct to the Adjutant General. When the death occurs away from the officer's station, in hospital or on leave, it is the duty of the Army Medical Officer, if there be one in charge, or of any officer having cognizance of the fact, to make the report. A duplicate of the report is sent to Department Headquarters. Inventories of the effects of deceased officers, as required by the 125th Article of War, are transmitted to the Adjutant General of the Army. If legal representatives take possession of the effects, it is so stated on the inventory and the report of death. If there be no legal representative present to receive the effects, a list of them is sent to the nearest relative of the deceased officer. At the end of two months, if not called for, they are sold at auction and accounted for as in the case of deceased soldiers; except that swords, watches, trinkets, and such articles are labeled with the name, rank, regiment, and date of death of the owner, and sent through the Adjutant General to the Second Auditor of the Treasury for the heirs. On the death of any officer in charge of public property or money, the Commanding Officer appoints a Board of Survey to take an inventory of the same, which he forwards to the proper Bureau of the War Department; and he designates an officer to take charge of the said property or money till orders in the case are received from the proper authority. Funeral expenses of officers who die at a military post or station are ordinarily not a proper charge against the Appropriations for the Army. Expenses "of the interment of officers killed in action, or who die when on duty in the field, or at posts on the frontiers, or when traveling on orders," may, under certain circumstances, be ordered paid by the Secretary of War. But, except when emergency requires that the Commanding Officer of the Department or District shall order the body to be transported from the battle-field to a suitable place of interment at the nearest town, post, or station, before the approval of the Secretary can be obtained, such approval must be had in advance. No accounts are paid for any such expenditure until the approval of the Secretary of War in writing is obtained. The unclaimed remains of officers or soldiers who may die at temporary camps, or on detached service, are decently inclosed in coffins and transported by the Quartermaster's Department for burial at the nearest military post or national cemetery, unless the Commanding Officer deem burial at the place of death to be proper.

Inventories of the effects of deceased soldiers required by the 126th Article of War are prepared in triplicate, two copies to be forwarded to the Adjutant General by the Commanding Officer of the company to which the deceased belonged, together with final statements of pay, clothing, etc.; the other copy to be retained with the company records. Each inventory is indorsed, "Inventory of the effects of ——— ———, late of company (—), ——— regiment of ———, who died at ———, the ——— day of ———, 18—." When a soldier, absent from his company, dies at any post or station, it is the duty of his immediate Commander to furnish direct to the Adjutant General the required inventories and final statements, and at the same time to forward to the Commanding Officer of the company to which deceased belonged a report of his death, specifying the date, place, and cause; to what time he was last paid, and the money or other effects in his possession at the time of his decease; and if a legal representative receive the effects, it is so stated in the report. If the soldier leave no effects, that fact is reported. This report is noted on the next muster-roll of his company. Should the effects of a deceased soldier not be administered upon within a short period after his decease, they are disposed of by a Council of Administration, under the authority of the Commanding Officer of the post, and the proceeds deposited with a Paymaster to the credit of the United States until they are claimed by the legal representatives of the deceased. In all such cases of sales by the Council of Administration a statement in detail or account of the proceeds, duly certified by the Council and Commanding Officer, accompanied by the Paymaster's receipt for the proceeds, are forwarded by the Commanding Officer to the Adjutant General. The statement is indorsed, "Report of the proceeds of the effects of ——— ———, late of company (—), ——— regiment of ———, who died at ———, the ——— day of ———, 18—." The effects in all cases are turned over, when called for, to the legal representatives without further authority from the Adjutant General. When the effects are turned over to the relatives of the deceased, before these inventories are sent to the Adjutant General, their receipts therefor are attached to the inventories. In all other cases one copy of the receipt is sent with a letter of transmittal to the Adjutant General, and a duplicate retained with the company. Receipts in duplicate are taken from the Paymaster for funds turned over to him—one copy to be sent direct to the Adjutant General, and one retained with the company.

DECHARGEURS.—Men appointed to attend the park of artillery, and to assist the non-commissioned officers, etc., who are employed on that service. It is the duty of the former to keep a specific account of articles received and consumed, in order to enable the latter to furnish their officers with accurate statements.

DECIMATION.—A military punishment, rarely inflicted in the present day. When a considerable body of troops committed some grave military offense, which would be punished with death if committed by an individual, the punishment was awarded to one tenth of them by lot, instead of to the whole number, in order that the army might not be too much weakened.

DECISIONS.—In Courts-Martial, the majority of the votes decides all questions as to the admission or rejection of evidence, and on other points involving law or custom. If equally divided, the doubt is in favor of the prisoner or accused.

DECLARATION OF INDEPENDENCE.—The American Declaration of Independence was agreed upon July 4, 1776, by the thirteen American Colonies then in revolt against England. Its history is brief but important. Early in 1776 the Delegates in Congress from Massachusetts were directed to vote for independence of England. Soon afterwards several other Colonies sent similar instructions. Washington wrote: "A reconciliation with Great Britain is impossible. When I took command of the army I abhorred the idea of independence; but I am now fully satisfied that nothing else will save us." Pennsylvania and New York were the last to acquiesce in the demand for a declaration. The tenor of these instructions to the Delegates from their constituents was in favor of cutting loose from Great Britain entirely and forming an independent government. June 7, 1776, Richard Henry Lee moved in Congress that "These United Colonies are and of right ought to be free and independent States." Four days later the motion was adopted, and two Committees were raised to present a Declaration and the Plan of a Confederation. On the Declaration Committee were Jefferson, Franklin, John Adams, and Roger Sherman. They reported June 28, but action was delayed, as the New York and Pennsylvania Delegates, having received no special instruction, thought they had no authority to vote for the Declaration. The Declaration of Independence was drafted by Thomas Jefferson, and but very slightly changed from his copy. When it came up for final action it received the vote of every Delegate. The vote was taken by Colonies, and every Colony gave unanimous approval. It was immediately signed by the names of 56 members present, and as soon as the slow means of printing and circulating in those days could spread it, it went forth not only as the defiant answer of the Colonies to the demands of the mother-country, but as a claim for the political emancipation of mankind. It ought to be known by heart by every boy and girl in America. Not many years ago the reading in full of the Declaration of Independence was considered as necessary in any social celebration of the 4th of July as a prayer in religious services; but in these days, partly from carelessness, but more from the large infusion of foreigners whose habits and ideas have greatly modified the primitive notions of our own people, the custom has fallen into disuse.

DECLARATION OF WAR.—The formal announcement by a government of its intention to wage war against another is a proceeding which is observed among all civilized nations. In the United States the declaration of war is a power exercised by Congress alone. During the Age of Chivalry, a Herald made declaration of war at the enemy's Court, his tabard on his arm.

DECLINATION-NEEDLE. — When a magnetic needle is suspended or made to rest on a point so as to be free to move in a horizontal plane, it finds its position of rest in a line joining two fixed points on the horizon; and when made to leave that position, after several oscillations, it returns to it again. At certain places on the earth's surface these two points are the north and south points of the horizon; but generally, though near, they do not coincide with these. A vertical plane passing through the points on the horizon indicated by the needle is called the magnetic meridian, in the same way that a similar plane, passing through the north and south points, is known as the astronomical meridian of the place. The angle between the magnetic and astronomical meridian is termed the declination or variation of the needle. The declination is east or west according as the magnetic north lies east or west of the true north. Instruments for determining magnetic declination are called declination-needles, or declinometers. In this instrument there are two things essential—the means of ascertaining the astronomical meridian, and a needle for showing the magnetic meridian. The common form of declinometer consists of a tripod provided with leveling-screws, and supporting a pillar, to which is fixed a graduated azimuthal circle. A compass-box, with vernier attached, moves on the azimuthal circle by means of a pivot at the top of the pillar. Two uprights are fixed to the side of the compass-box, on which rests the axis of a telescope. A graduated arc is fixed to the bottom of one of the uprights, and the angle of elevation of the telescope is marked by a vernier on the arm attached to the axis of the telescope. A level is also hung on the axis of the telescope for adjusting the instrument. Inside the compass-box is another graduated circle, the line joining the zero-points of which is parallel to the axis of the telescope. All the fittings are in brass or copper, iron, of course, being unsuitable. The compass-box and telescope move round as one piece on an axis passing through the center of the azimuthal circle. When an observation is made, the telescope is pointed to a star whose position with regard to the astronomical meridian is known at the time of observation. The telescope with the compass-box is then brought the proper number of degrees on the azimuthal circle, until its axis is in the meridian of the place. If, when the telescope is in this position, the north end of the needle stand at the zero-point of the inner circle, the declination would be 0 ; but if it lie east or west of this point, the declination is shown by the degree at which the needle stands. It is difficult to construct a needle so that the line joining its poles exactly coincides with the line joining its visible extremities. If this coincidence be not perfect, the geometrical axis of the needle according to which the reading is made lies to the right or left of the magnetic axis, and consequently of the true reading. To remedy this, the needle is so made that it can rest either on its lower or upper surface. In finding the true reading, the position of the needle is marked, and then it is turned upside down and again marked, the mean of the two readings giving the true one. The declination of the needle may be also ascertained by the dipping-needle. The ordinary compass which must be used by making allowance for declination is a declination-compass. See *Dipping-needle* and *Magnetism.*

DECOMPTE.—A liquidation or balance which from time to time was made, in the old French service, between the Captain of a company and each private soldier for money advanced or in hand.

DECORATION-DAY.—The anniversary, in the United States, on which flowers are placed on soldiers' graves, and which is observed on May 30th. This day was set apart for the purpose mentioned soon after the War of the Rebellion.

DECORATIONS.—In pyrotechny, the compositions which are placed in the heads of rockets, in paper shells, etc., to make a brilliant display when the receptacle is burst. See *Pyrotechny.*

DECOUPLE.—In Heraldry, a term signifying severed or disjoined, so that the ends stand at a distance from one another; as, a *chevron decouplé.*

DECOY.—To lead or to entice into a snare; to lead into danger by artifice; to entrap. An enemy is said to be decoyed when a small body of troops draws them into action, while the main body lies in ambush ready to act with the greatest effect.

DECREMENT.—An heraldic term by which the wane of the moon is indicated. A *moon decrescent* is a half-moon with her horns turned to the sinister. The terms *decrescent* and *decours* are likewise used.

DECURIO—DECURION.—A Roman cavalry officer, commanding ten men. Decuriones Municipales were Roman provincial magistrates who had the same power in free and corporate towns as the Senate had in Rome. At first numbering 10, as their name implies, they frequently numbered 100 in later times. Their duty was to watch over the interests of their fellow-citizens, and increase the revenues of the commonwealth. They were required to be 25 years of age, and to possess a certain income. The legion was officered by six *Tribunes*, sixty *Centurions*, with an equal number of officers who served as file-closers for the infantry; and twenty *Decurions* of cavalry; besides these there were the officers of the velites, who fought out of the ranks.

DEEP.—A term used in the disposition or the arrangement of soldiers placed in ranks before each other; hence two deep, three deep, etc. *Deep line of operations*, a long line.

DEFAULT.—The common expression for a military offense in the British service.

DEFAULTER-BOOK.—A book in which the record of crimes committed by soldiers is entered. There are two defaulter-books in a regiment, the *company* and the *regimental*. In the former all offenses of whatever description committed by non-commissioned officers and soldiers, whether punishment may have been awarded or not, and every act of drunkenness committed by a soldier, are inserted. Cases of absence, which may be considered equivalent to drunkenness, are not to be so numbered, but in lieu thereof the letter D is to be inserted in *red ink* opposite every such case, by the officer commanding the company. All offenses are to be inserted in the officer's own handwriting. In the latter, or regimental defaulter-book, all punishments awarded by the Commanding Officer of the regiment, or by Courts-Martial, are inserted. In this book also all offenses are to be entered for which a punishment exceeding seven days' confinement to barracks has been awarded.

DEFAULTERS.—1. Soldiers who have been guilty of military offenses. The term is generally applied to men sentenced to confinement to barracks, and attaches to them until the completion of their punishment. 2. If any officer employed or who has heretofore been employed in the Civil, Military, or Naval Departments of the Government to disburse the public money appropriated for the service of those Departments, respectively, shall fail to render his account or pay over, in the manner and in the times required by law, or the regulations of the Department to which he is accountable, any sum of money remaining in the hands of such officer, the First or Second Comptroller of the Treasury, as the case may be, shall cause to be stated and certify the account of such delinquent officer to the Solicitor of the Treasury, who shall immediately proceed to issue a warrant of distress against such delinquent officer and his sureties, directed to the Marshal or Marshals of the district or districts where they reside; and the Marshal shall proceed to levy and collect the sum remaining due by distress and sale of goods and chattels of such delinquent officer; and, if the goods are not sufficient, the same may be levied upon the person of such officer, who may be committed to prison, there to remain until discharged by due course of law. But the Solicitor of the Treasury, with the approbation of the Secretary of the Treasury, may postpone for a reasonable time such proceedings where, in his opinion, the public interest will sustain no injury by such postponement. If any person shall consider himself aggrieved by any warrant issued as above, he may prefer a bill of complaint to any District Judge of the United States, and thereupon the Judge may, if in his opinion the case requires it, grant an injunction to stay proceedings. If any person shall consider himself aggrieved by the decision of such Judge either in refusing to issue the injunction, or, if granted, on its dissolution, such person may lay a copy of the proceedings had before the District Judge, before a Judge of the Supreme Court, who may either grant the injunction or permit an appeal, as the case may be if, in his opinion, the equity of the case requires it. The judgment on a warrant of distress under this Act, and the proceedings under the judgment, are a bar to any subsequent action for the same cause. No money appropriated shall be paid to any person for his compensation who is in arrears to the United States, until such person shall have accounted for and paid into the Treasury all sums for which he may be liable: provided, that nothing herein contained shall be construed to extend to balances arising solely from depreciation of treasury notes received by such person to be expended in the public service; but in all cases where the pay or salary of any person is withheld, in pursuance of this Act, it shall be the duty of the Accounting Officers, if demanded by the party, his agent or attorney, to report forthwith to the agent of the Treasury Department the balance due; and it shall be the duty of the said agent, within sixty days thereafter, to order suit to be commenced against such delinquent and his sureties.

DEFEAT.—The rout or destruction of an army by an enemy. Strictly the word expresses the complete want of success of an army; a repulse signifying less, and a rout more, than defeat. It is also used to mean resistance with success; as, to defeat an assault.

DEFECTION.—The act of abandoning a person or cause to which one is bound by allegiance or duty, or to which one has attached himself. See *Abandon*.

DEFENCE—DEFENSE.—1. In military law, the defendant's answer to the plea, or the method of proceeding adopted by the defendant to protect himself against the plaintiff's action.

In point both of law and reason, a Court-Martial has as much power over the evidence introduced by the prisoner as over that of the prosecutor, and can reject the witnesses of the one as well as the other, or any part of such witnesses' testimony. Courts-Martial are particularly guarded in adhering to the custom which obtains of resisting every attempt on the part of counsel to address them; but cases have occurred in which professional gentlemen in attendance have been permitted to read the defense prepared for the prisoner. A Court will prevent a prisoner from adverting to parties not before the Court, or only alluded to in evidence, further than may be actually necessary. All coarse and insulting language should be avoided in any part of the defense.

2. In fortification, all sorts of works that cover and defend the opposite posts. The parapets of all coast and harbor defenses should be constructed of earth, where favorable sites can be found; but for low sites that can be approached within grape-shot range such batteries must give place to masonry defenses; and where masonry-casemated castles with three tiers of guns in casemates, and with guns and mortars on the roofs, are resorted to, embrasures of wrought-iron will be found applicable. With such batteries well constructed, the direct fire of ships has little effect. Movable columns of troops in numbers, depending on the probable object of the enemy, must be held in some central position. If railroads are to convey the troops, a central point within a radius of sixty miles will be within good supporting distance. If railroads are not relied on, the distance should not be greater than fifteen miles. The columns should be at least seven tenths infantry, one tenth cavalry, and two tenths field-artillery; the latter being useful to oppose the debarkation of troops. The French charge both the fleet and the army with the movable defense of coasts. Steamers and flotillas, armed with howitzers, are particularly suited to that object. Corps of troops assembled at some central position are held ready to be thrown upon a threatened point. Batteries of howitzers give

their aid to these corps. Concerted signals are carefully arranged.

The defense of works attacked by regular approaches calls for the most active and vigilant exertions on the part of the besieged, especially so from the artillery. So soon as the operations of the besieger indicate what work of a line, or the particular part of a work, is his objective, every effort must be made to restrict the extent of his lines of envelopment. To this end, adjacent and collateral works must be armed with pieces of the heaviest caliber, so situated as to take the lines of approaches as much as possible in flank. These batteries will give special attention to the long-range batteries of the besiegers. Every available piece of artillery must be brought forward and placed in battery so as to strike the besiegers at some point or other. Unremitted fire must be maintained against the heads of the approaches; these, from their open character, are peculiarly vulnerable to mortar-fire. As many mortars as possible should be placed in batteries established for this special purpose. It is not advisable to crowd artillery into the objective point of the enemy, but rather to the right and left of it; this secures a cross-fire, and at the same time withdraws the pieces from the points upon which the besieger concentrates his fire. If an assault is to be apprehended, batteries, especially of machine-guns, should be established so as to sweep the ditch and prevent the enemy from making a lodgment by digging into the scarp and parapet. These batteries must be well secured by means of bomb-proof covers and gun-shields. Traverses must be thrown up to protect the guns, and bomb- and splinter-proofs constructed to shelter the cannoneers. An interior line of intrenchments should be constructed in rear of that part of the main work attacked. This should be well supplied with light pieces of artillery, which may be kept under cover until the proper moment and then run up to drive the enemy from his lodgment on the main work. The supply of ammunition must be closely attended to, and under no circumstances, where it is possible to avoid it, should it be allowed to fall below the probable needs. All of the operations of the artillery in the defense, as well as in the attack, should be directed by one head. See *Harbor Defenses.*

DEFENSIVE BATTLE.—In a purely defensive battle, an army chooses a position in which to await the enemy and there to give battle with no other end in view than to hold this position and repulse the enemy. The fact that a party acts on the defensive supposes something wanting either in the numbers or efficiency of his troops; either of which defects can only be remedied by resorting to aids, offered either by nature or art, for restoring the equilibrium between the opposing forces. There is one point that needs to be strongly inculcated, which is that a position should not only be strong tactically, but good strategically. It should not only lend itself to the maneuvers of our troops and to the efficacy of their fire; but, if forced, should favor a safe retreat. The advantages offered by heights for the defensive may induce into serious disaster a General who takes a position of this kind from purely tactical considerations, without regard to their strategical bearing; or, when this latter consideration does not come up, who looks simply at the defensive properties without examining also the advantages that a skillful enemy, operating offensively, might derive from them.

Suppose an army to occupy a ridge of heights, crossing obliquely its line of retreat; its right resting on an inaccessible obstacle. Now, an army advancing to the assault of this position might look upon it in two aspects. First, strategically, seeing that by making the attack on the right, although the ground there is the most difficult, it will force the assailed back, so as to expose his line of retreat, and may therefore be well worth the effort and cost. Second, tactically, to assail vigorously the more exposed left wing, and, throwing it back on the right, necessarily produce a disaster; as the character of the ground, a narrow plateau, is supposed to be such that it will not admit of a change of position of the assailed to meet this attack in front. However otherwise advantageous, it would evidently be imprudent then for a General to take up a position of this kind, unless so superior to the enemy that he will be able to foil an attack on either wing. There remains, however, one more resource to the General, in a similar case, when he has ample time to employ it, and that is fortification. This is one that every great General has, at one time or another, availed himself of, and, in every case, with advantage. Military history is full of examples where the scale of great and decisive battles has turned on the taking or holding a mere field-work that had occupied but a few hours' time to throw up. This, however, belongs to the domain of fortification, one of the most difficult as most important branches of the military art, and which demands for its proper exercise military qualifications of a high order. There probably has existed no great engineer who, when called upon, has not shown himself a superior General; nor a great General who did not fully acknowledge and appreciate the art of fortification.

Where an army is forced to accept a defensive battle in an open position, which affords no points on which its flanks can rest with security, there is but one disposition of combat open to it, and that is to secure the wings by such an accumulation and distribution of troops upon them that the assailant will run a greater risk in an attack on one of them than on the front. The center in this case will be deployed in the first line, so as to bring all its fire to bear, both direct and cross, over the approaches to it. The troops to support the wings will be massed, so as to be ready to act promptly, as the phases of the action may demand; and the reserve will occupy a central position in the rear, from which it can promptly be thrown upon any point pressed by the assailant.

It is in such positions that the formation of the order of battle by squares is resorted to when the assailant is very superior in cavalry. This is done either by a formation of small squares by single battalions, or by resorting to larger ones, as to those formed of four or more battalions. The first have the advantage of being very promptly formed, but they afford hardly more interior space than is wanted for their own staff, leaving whatever cavalry and artillery we have to find shelter between the squares. The large squares demand more complication of maneuver, and more time in their formation, but afford a large interior space, where the caissons of the artillery, and even the cavalry, if in small numbers, may find shelter. In this last disposition some of the artillery would be in battery in front of those angles of the squares where its fires can best sweep the approaches on the two adjacent sides of the square; other portions will be in the intervals of the squares, so as to throw a flank and cross fire over the approaches to them. The sharp-shooters may be advanced a little on those angles which are not occupied by the artillery so as to strengthen these weak points. The cavalry, if in sufficient force to charge opportunely, will take post between the squares, where it will be least exposed to the enemy's artillery, and be ready to seize the proper moment for entering into action. See *Battles, Mixed Battle,* and *Offensive Battle.*

DEFENSIVE PATROLS. — That class of patrols made with a view of insuring greater security from the enemy's attempts to pass or force the line of outposts. They consist usually of three or four men, who go the rounds, along the chain of sentinels and between the posts; seldom venturing farther than a few hundred paces beyond the sentinel's chain; the object being to search points which might present a cover to the enemy's scouts, and to keep the sentinels on the alert.

DEFENSIVE WAR.—A war undertaken to repel invasion or the attacks of an enemy. Defensive war may be divided into three kinds. It is either a war sustained by a nation which is suddenly attacked by another who is superior in troops and in means; or a nation makes this sort of war by choice on one side of its frontiers; or it is a war become defensive by the loss of a battle. See *War*.

DEFERRED PAY.—An increase of 2*d*. per diem granted by Parliament to the non-commissioned officers and soldiers of the British army and Reserve, under the following conditions: The 2*d*. per diem for the Army with the Colors to be payable on the discharge or death of every non-commissioned officer or man, in respect of all service (previously to the completion of 12 years' service) from April 1, 1876. The 2*d*. per diem for the Army Reserve to be paid annually in arrear to all men in it. Any sum earned by a man dying during the year to be paid to his representatives. £1 per man, now paid for necessaries, not to be payable to men accepting the new terms.

DEFILADING.—That part of the art of fortification which consists in determining the directions and heights of the lines of rampart, so that the interior may not be commanded by the fire of any works which the enemy may raise. Defilading is divided into horizontal and vertical. The object of the first is to prevent the lines being commanded in the direction of their length, or enfiladed; the prolongations of the lines, therefore, must avoid all points where hostile works could be erected. Vertical defilading determines the height of rampart necessary to protect the interior from direct fire. See *Defilement*.

DEFILE.—In a military sense, any narrow place the passage of which can be made by troops only when undeployed. Mountain-passes, river-crossings, narrow isthmuses, and roads through close forests represent the usual forms of defiles. They necessarily imply obstacles in the way to the free movement of armies, and are therefore important features in a theater of war, and consequently points demanding special attention by way of defensive arrangements. For these no precise rules can be laid down; nevertheless some general principles may be stated. The chief advantage offered by a defile is, that with but comparatively slight intrenchments a small force is able to hold a position against a much greater; this for the reason that, owing to the essential nature of a defile, the attacking force must operate in a constrained position, not admitting of much development of fire. The main object, therefore, is to secure such a column of fire over the defile as to make it impossible for the enemy to stem it; this is best accomplished by selecting such points as will give an enfilade fire. They should be selected with a view to mutual support, and intrenched in such manner as to be secure against capture by *coup de main*. The enemy must be compelled to make his attacks with divided forces and inferior numbers. This is best accomplished by occupying several positions within flanking distance of each other. He will, probably, not be able to attack all simultaneously, and it will be a costly operation for him to attack them in detail.

The positions should be so chosen as to allow them to concentrate their artillery-fire upon any point where it might be advantageous for the enemy to establish batteries, and the artillery of the defense should be of such power as to preclude all possibility of his doing so. All hollow approaches, such as would be formed by ravines in a mountain-pass, must be searched by the fire of artillery. This, as a rule, will require pieces to be placed in open batteries exterior to the inclosed works. Such batteries must be well supported by infantry sheltered in rifle-trenches. The whole system should be so connected as to leave no part isolated or without the support of other parts, and the defense of each point must be stubborn in the extreme to prevent the enemy from gaining possession of advantageous positions. All parts of the line or group of works must be in communication by telegraph, telephone, or signaling, or by all three. This is a matter of the greatest moment in securing not only the physical but also the moral support of the parts. In every case artillery should form a chief feature in the means of defense; the kind of pieces for the different parts of the system will depend upon the character of the ground and of the nature of the attacks that may be expected. As a rule, all approaches must be covered by fire; wherever horizontal fire cannot be made to reach, mortars must be used. However much the pieces may be scattered, they must be capable of concentrating their fire upon any position the enemy may assume.

If a defile is to be held for the purposes of an army either advancing or retiring in front of an enemy, the head of it towards the enemy must be secured by a line similar to a *tête-de-pont;* this for the purpose, if advancing, of giving room for the army to deploy after passing the defile, and to prevent the enemy from striking it while defenseless in column; if retreating, the same disposition is necessary to hold the pursuing army in check while the troops are defiling to the rear. In both cases, as the object is to keep the enemy from closing in for a pitched battle, artillery must be freely used. In the attack upon a defile, intrenched, armed, and defended as it should be, artillery will be the most important weapon; this for the reason that, from the very nature of defiles, other arms can act but feebly, while artillery possesses the power of reaching its object beyond intermediate obstacles. As much artillery should be brought to act as possible, and, although it may be widely dispersed, its fire must be concentrated upon some particular work in the system of defenses. The work must be attacked with such vigor and persistency as to insure its destruction and easy capture. Other works are successively attacked in the same manner. The operations upon both sides thus partake of the nature of a siege, and are governed by the same principles.

DEFILEMENT.—Where the site of a field-work is sensibly horizontal and there are no commanding points within cannon-range from which an assailant can get such a view into it as to regulate his fire with some certainty, there is no controlling motive for making the relief other than uniform; though it lessens, to some extent, the effects of an enfilading fire, by making a face higher at the salient, giving it a uniform slope back, as the higher the covering mass over which the fire of the assailant must pass to reach the interior of a work, the greater will be the portion of the work screened. The extent of the cover thus gained will depend upon the angle of elevation and the charges with which the assailant's fire is maintained. With great angles and heavy charges from considerable distances, and great angles and light charges when near to the work, the projectile may receive a great plunge in the descending branch of its trajectory, so as to fall quite close behind the covering object; but these great plunges are unfavorable to ricochet, so that if the assailant wishes to preserve this fire, which is generally regarded as the most effective in enfilading the interior of a parapet, he must sacrifice the effect of great plunges, and submit to the advantage of better cover which the assailed gains by raising his salients, or using traverses for the same end. When the site is not horizontal and there are commanding heights from which the interior of the work can be plunged into, by firing under small angles of depression, or ground lower than the work from which a reverse fire can be obtained, on the more elevated portions, over the parapet of the lower portions, the parts thus exposed must be screened either by raising the parapet to a suitable height, or by interposing a covering mass within the work for the same object. The operation by which this is effected is termed *defilement*, and when a work is thus screened it is said to be *defiled*.

Defilement is seldom practicable, nor in fact is it necessary for lines of any considerable extent. The most that can be attempted is so to vary the plan, when it can be done and not impair the efficiency of the fire of the different parts on the approaches, as to prevent the prolongation of any important face or flank from falling on any point where the assailed would have a commanding position to enfilade; rather giving those parts a direction such that their prolongation outwards shall fall on low ground, or on points inaccessible to the artillery of the assailed. No specific rules can be laid down further than of a general character. Taking, for example, a line of works to be thrown up within cannon-shot of a range of heights the crests of which lie in the same direction and are sensibly horizontal, the best cover that could be obtained in this case would be a simple right line of uniform relief, the direction of which should be parallel to that of the crests. If the site on which the line is placed is horizontal, by giving a good height to the parapet a sheltered zone for the troops and *matériel* of more or less extent will in this way be obtained. If the site slopes much from the range of heights, then the same height of parapet will mask a broader zone of shelter, and the more so as the declivity of the surface is the more decided. But if the site slopes towards the crests, then the difficulty of obtaining shelter will be the greater as this counter-slope is the greater. If instead of a right line a broken line is used, as a redan or a serrated line, then it will be well to make the face of each redan or tenaille as short as practicable, and to make the salient angles very obtuse. In this manner but short lines will be presented to an enfilading fire, and the prolongations of these lines be brought to intersect the crest of the range at more distant points, thus forcing the assailant to use higher angles of elevation to reach them from his enfilading position. When the line of the crests descends in a right line towards the site, then supposing the general direction of the parapet to be a right line, the most favorable position for the defilement, by a uniform relief given to the line, will be to give the line of the parapet a direction upon the point where the line of the crests prolonged would meet the site. The zone of shelter covered by the parapet in this case will be so much the greater, and the defilement the better, as the general direction of the parapet makes a greater angle with that of the crest. The same remarks apply to a sloping or counter-sloping site. As the position of the works become the less restricted, there will be freer play for the skill and eye of the engineer to obtain a good solution of the question. For works open at the gorge and inclosed works defilement becomes more important, as, the force being small, every means should be employed for its safety. In such works there is also much less freedom to vary the plans. The most that can be done is to avoid enfilading or reverse views, by opening more or less the salient angles so as to bring the more prominent dangerous points within the angle of the adjacent faces prolonged, or to bring those prolongations upon dangerous points as distant as practicable. In the first case a reverse fire on either face will be avoided, and in the second the enfilading position of the assailant will be thrown to a further distance. The *defilement* of field-works is not indispensable to a good defense; nor is it always practicable. It is, however, not only a conservative means, but it also inspires the assailed with confidence; for the soldier regards with much distrust the strength of his position when he finds himself exposed to the plain view of the enemy from an elevated point.

For the solution of all problems of the defilement of permanent works the engineer requires: 1. The limit exterior to the defenses beyond which the effect of the enemy's fire may be regarded as so uncertain as to be neglected. 2. The presumed positions within this limit that the enemy may take up to bring his artillery to bear upon the works. 3. An accurate topographical map of all the ground within the above limits, as given by its horizontal curves referred to a plane of comparison. 4. The magistrals and interior crests of the works, as either definitely or proximately arranged, referred to the same plane. The limits beyond which the enemy's fire, from the usual *smooth-bore siege-guns*, may be disregarded, owing to the uncertainty of long ranges, are 1500 yards, where the work is exposed only to a direct or front fire, and 2000 yards when open to a reverse fire. For *rifled guns*, which will hereafter be used in all siege-operations, these limits should embrace all the exterior ground within the accurate range of the heaviest guns of this class. When the terre-pleins, therefore, are covered, either by their parapets or other means, from batteries at these distances, they may be considered as offering shelters sufficiently secure for the troops, etc., upon them. It may happen that there are points beyond these limits, but within the extreme range of siege-guns, which, from their positions, it would not be safe to disregard; but these will form exceptional cases, and, when they occur, will be treated in the same manner as those within the limits. The surface of the site embraced within the exterior limits and the line of defenses may be divided into *three* zones; *one* lying between the limits and the position of the first parallel of the attack; the *second* between the positions of the first and second parallels; the *third* between the positions of the second and third parallels. In any position that the assailant can take up for his batteries, within the first zone, it is usually estimated that he will not throw up any parapet with a greater command than 10 feet over the ground on which it is placed. Granting this, the muzzles of his guns, behind the parapets, will not be raised higher than 6 feet above the natural surface; so that assuming the surface of this first zone to be raised 6 feet above its true position, this may be regarded as the limit, vertically, within which the assailant's lines of fire will be restricted; and therefore if the interior of the defenses is covered from the fire within this limit, the troops, etc., will be secure. That the assailant will not in all likelihood elevate his guns above this limit will seem probable, when it is taken into consideration that any advantage he might derive from doing so would not be commensurate with the labor it would cost him. For suppose the enemy to have taken up a position for an enfilading battery at 1000 yards from any salient, to enfilade one of its faces of the length of 100 yards, and that he should decide upon raising his guns 3 feet, or 1 yard, above the limit just laid down; a simple proportion will show that by this increase in the height of his battery he will be able to attain a point at the farther end of the face only 3.6 inches lower than he would have done in the position of the assigned limit—an advantage which, considering the uncertainty of the fire at the assumed ranges, would hardly compensate the additional labor of giving to his works the additional command. In the zone between the first and second parallels the limit may be reduced to 4½ feet; for at this distance from the defenses their fire is so destructive and certain that the enemy cannot, without great loss of life and time, raise the parapet of his batteries higher than 8 feet above the natural surface. From the third zone the musketry of the enemy may be brought to bear upon the defenses; and from this position, during sorties from the defenses, or at any other opportune moment when their fire is not active, the enemy might mount on the parapet of his trenches, and from there deliver his fire. This would bring his line of fire about 10 feet above the natural surface. The limit, vertically, of this zone may therefore be safely assumed at 10 feet above the natural surface.

In the defilement of each part separately of the line of defenses, those portions alone of these zones should be regarded as dangerous which are embraced within arcs, or other lines drawn at the foregoing distances from the salients, or the faces of the part to be defiled. It may also happen that, within the limits of dangerous ground for one portion of the line of defenses, there may be other portions which, from their position, may mask the portion to be defiled from all the dangerous points beyond them; in which case the points thus shut off need not be regarded, in effecting the operations of defilement. Within the limits of the zones of danger, positions may be determined for front, for reverse, and for enfilading fire. If the two faces, for example, of a work be prolonged to intersect the extreme limit of dangerous ground, the sector which they embrace may be termed *the limits of direct* or *front fire;* since, from every position that can be taken up within this sector, a direct fire alone can be brought to bear upon the two faces. The two sectors which lie adjacent to this may be termed *the limits of lateral* or *reverse fire*, since they afford positions from which a reverse fire can be obtained against one of the faces, and a front fire upon the other. It is also only within these last limits that positions for enfilading the terre-pleins of the faces can be obtained. The problems of defilement which present themselves for solution may embrace one or more of these cases in any example; depending upon the relative positions of the interior crest of the work to be defiled, and of the dangerous ground embraced within the foregoing limits. In the case of direct fire alone, the terre-pleins can be screened by their parapets. In that of a reverse fire on one face alone, its terre-plein, in some cases, may be screened by a suitable position assigned to the parapet of the other. Where both are exposed to this fire, one or more traverses must be resorted to as a screen. Against an enfilading fire on one face alone, a portion of the parapet of the other, near the salient, may be a sufficient protection in some cases; but, for the most part, traverses, placed across the terre-plein, will be the only remedy. See *Direct Defilement* and *Reverse Defilement.*

DEFLAGRATION.—A term applied to the rapid combustion of ignited charcoal when a nitrate (such as nitrate of potash) or a chlorate (such as chlorate of potash) is thrown thereon. As chlorates do not occur naturally, it follows that deflagration with a natural salt indicates a nitrate; and if the deflagration be accompanied by a violet flame, it is characteristic of nitrate of potash (ordinary niter or saltpeter); and if by a strong yellow flame, it is indicative of nitrate of soda (cubical niter).

DEFORMER.—In a military sense, this word signifies to break; as, *deformer une colonne,* to break a column.

DEGAT.—The laying waste an enemy's country, particularly in the neighborhood of a town which an army attempts to reduce by famine, or which refuses to pay military exactions.

DEGORGEOIR.—A sort of steel pricker used in examining the vent of a cannon; a priming-wire.

DEGRADATION.—In military life, the act of depriving an officer forever of his commission, rank, dignity, or degree of honor, and taking away at the same time every title, badge, or privilege he may possess.

DEGRADED.—A term in Heraldry signifying placed upon steps or degrees, as in a *cross Calvary.*

DEGREE OF LATITUDE.—A space along the meridian through which an observer must pass to alter his latitude by one degree—i.e., in order to see the same star one degree nearer to or further from the zenith. The space must be found by actual measurement; and owing to the earth being an oblate spheroid, and not a sphere, it varies with the place of observation—the degrees being generally longer towards the poles, where the earth is flatter, and shorter at the equator, where the earth is more curved. If the earth were a sphere, a degree would be exactly a 360th part of the meridian. As it is, the length of a degree of latitude depends on the latitude of the place. From a variety of observations conducted at various times and places, from as far back as the time of Eratosthenes (250 B.C.), tables have been constructed showing the length of degrees at different latitudes. The length of "the middle degree," as it is called, or that of places in latitude 45 , may be taken approximately at $69\frac{1}{10}$ English miles. The ascertained differences between degrees of latitude is one of the proofs of the earth's spheroidicity.

DEGREE OF LONGITUDE.—The space between two meridians that make an angle of 1 at the poles, measured by the arc of a circle parallel to the equator passing between them. It is clear that this space is greatest at the equator, and vanishes at the poles; and it can be shown that it varies with the cosine of the angle of latitude. The annexed table shows the lengths of a degree of longitude for places at every degree of latitude from 0° to 90 . It is computed on the supposition that the earth is a sphere.

Deg. lat.	English miles.	Deg. lat.	English miles.	Deg. lat.	English miles.	Deg. lat.	English miles.
0	69.07	23	63.51	46	47.93	69	24.73
1	69.06	24	63.03	47	47.06	70	23.60
2	69.03	25	62.53	48	46.16	71	22.47
3	68.97	26	62.02	49	45.26	72	21.32
4	68 90	27	61.48	50	44.35	73	20.17
5	68.81	28	60.93	51	43.42	74	19.02
6	68.62	29	60.35	52	42 48	75	17.86
7	68.48	30	59.75	53	41 53	76	16.70
8	68 31	31	59.13	54	40.56	77	15.52
9	68.15	32	58.51	55	39 58	78	14.35
10	67.95	33	57.87	56	38.58	79	13.17
11	67.73	34	57.20	57	37.58	80	11.98
12	67.48	35	56 51	58	36 57	81	10.79
13	67.21	36	55.81	59	35.54	82	9.59
14	66.95	37	55.10	60	34 50	83	8.41
15	66.65	38	54.37	61	33.45	84	7.21
16	66.31	39	53.62	62	32 40	85	6.00
17	65.98	40	52 85	63	31.33	86	4.81
18	65.62	41	52.07	64	30.24	87	3.61
19	65.24	42	51.27	65	29.15	88	2.41
20	64.84	43	50.46	66	28 06	89	1.21
21	64.42	44	49.63	67	26.96	90	0.00
22	63.97	45	48.78	68	25.85		

DEHORS.—In the military art, all sorts of outworks in general, placed at some distance from the walls of a fortification, the better to secure the main places, and to protect the siege, etc.

DELF.—An heraldic charge, representing a square sod or turf, the term being derived, it is supposed, from the verb to *delve* or dig. A *delf tenné* is the appropriate abatement for him who revokes his challenge, or otherwise goes from his word. See *Abatement.*

DELINEATOR.—A perambulator, or geodetical instrument on wheels, with registering devices for recording distances between points; a pendulum arrangement by which a profile line is inscribed on a traveling strip; and certain other data, according to construction.

DELIQUESCENCE.—The power that certain salts have of attracting moisture and dissolving into water. Saltpeter has generally many deliquescent and impure salts in it, which in the process of refining it is freed from before being used for gunpowder purposes.

DELIVER BATTLE.—A term taken from the French *livrer bataille*, meaning to enter practically upon a contest; the opposing armies being in sight of each other.

DELIVERY.—The draught or allowance by which a pattern is made to free itself from close lateral contact with the sand of the mold as it is lifted. Also called *draw-taper.*

DELLIS.—The Bosnian and Albanian horsemen, who served without pay in the Turkish armies.

DELVIGNE LIFE-SAVING GUN.—This piece of ordnance weighs 20 kilos, is made of gun-metal, about 18 inches long, and has an iron tail-piece screwed into the breech and jointed, so that in firing it is simply thrust into the soil until the square breech brings up. The elevation is regulated by a quadrant and plummet put into the muzzle. The bore is about 1¼ inch, and the piece carries wooden arrows, fitted with iron tails to reach the charge; and at the muzzle these are much larger than the tail-piece, so that the shock of explosion operates on the square bases of the arrows, which are protected by rings of metal.

In loading this piece, a vacant space is left and the cartridge is fired near its outer end; the piece being very short, this brings the vent about in the center of the length. The iron arrows are about one third longer than the gun, and about half the length of the arrow is in the gun when ready to fire. The advantages claimed by Delvigne in this little piece are its cheapness and portability, while with sufficient charge it gives an equal or better range; besides the wooden and iron arrows he fires a wooden arrow out of the *perrier* or almost any gun, which has cross-bars of round iron made malleable to resist the shock. These cross-pieces are fixed at right angles to the arrow, near the outer end, and are about as long as three diameters of the arrow. It is found that in firing this the cross-pieces are bent to an angle of about forty-five degrees with the plane of the arrow, and thus form an anchor or grapnel, useful for many purposes. Arrows of wood have the advantage of floating if they drop near the wreck, and of being readily recovered when they go beyond or fall short. The iron flèche is intended for long ranges or strong contrary winds. The distance depends much on weather, on the amount of charge, elevation, and the line running clear.

In 1872 Delvigne's new gun, weighing 20 kilos (44.09 pounds), gave a range of 300 meters (328.09 yards), with a wooden flèche weighing 8 kilos (17.63 pounds), and a shot-line 8 millimeters (.315 inch) in diameter. See *Life-saving Rockets*.

DELVIGNE RIFLE.—A rifle having a chamber screwed into the breech at the bottom of the bore, which supplies an apartment for the powder. The shoulder of the chamber provides a place on which the ball rests, and thus preserves the powder. The ball enters freely, and is rammed and made to take the grooves. A sabot was subsequently attached to the under side of the ball, and attached to it was a patch of greased serge, which served to prevent fouling in the bore.

DEMEMBRE.—An heraldic term signifying that the members of an animal are cut from its body. Also written *Dismembered*.

DEMI—DEMY.—In Heraldry, an animal is said to be *demi* when only the upper or fore half of it is represented. In inanimate objects the dexter half per pale is usually intended, when it is said to be demi, though a *demi-fleur-de-lis*, for example, may be a *fleur-de-lis* divided per fess. See *Heraldry*.

DEMI-BASTION.—In fortification, a kind of half-bastion which frequently terminates the branches of a crown-work or horn-work, and which is also occasionally used in other places. See *Bastion*.

DEMI-CANNON.—A variety of ordnance, anciently used, carrying a ball ranging from 30 to 36 pounds in weight.

DEMI-CULVERIN.—An ancient piece of ordnance, carrying a ball weighing 9 or 10 pounds.

DEMI-FILE.—That rank in a French battalion which immediately succeeds to the *serre-demi-file*, and is at the head of the remaining half of its depth.

DEMI-GORGE.—In fortification, half the gorge or entrance into the bastion, not taken directly from angle to angle, where the bastion joins the curtain, but from the angle of the flank to the center of the bastion, or the angle which the two curtains would make by their prolongation.

DEMIHAG.—A very small arquebuse, of which the stock was bent or hooked, in order that it might be held more readily. It was much used in the sixteenth century.

DEMI-LANCE.—A light lance or half-pike; also the term for a light horseman who carried a lance.

DEMI-LUNE.—The object of this work is to secure the gates of the place from a surprise; to mask from the enemy's batteries the flanks and curtain of the enceinte; to give cross-fires on the salients of the bastions; and to favor sorties. The fire from the demi-lune is very effective on the enemy's works along the bastion capitals. Finally, it is a work of which the enemy can only obtain possession after great labor and loss of time; and when carried, it is with great difficulty that he can render it tenable, as it is exposed to the fire of the enceinte, within a short range. Engineers since Cormontaigne, finding that the demi-lune still admitted of being enlarged with advantage, have accordingly so determined its dimensions that it may be thrown so far to the front as will still place the breach which an enemy may make in its face within the range of the musketry of the bastion-face. In large fronts, like Noizet's, the demi-lune may be thus made to cover about 30 yards of the bastion-faces from the shoulder-angle, and thus secure retrenchments resting against this part from being turned by a breach made near the shoulder-angle. These considerations limit the salient angle of the demi-lune to 60°, and place the salient at not more than 210 yards from the bastion-face, as this distance will bring the breach at about 180 yards from this face, or within the effective range of musketry. The demi-lune thus arranged places the bastions, in all cases, in strong re-enterings; but when the angles of the polygon are very obtuse, the faces of the bastions prolonged also fall within the salients of the demi-lunes, and are therefore not easily enfiladed. The demi-lune, with numerous advantages, is not without defects. Its faces, from their position, are exposed to an enfilading fire; it deprives the curtain of all action on the exterior ground; and it is only when the angles of the bastion are very open that the re-enterings formed by the demi-lunes become of a formidable character. The glacis of the demi-lune covered-way forms a ridge, which is serviceable to the enemy by masking his works on one side of the ridge from the fire of the collateral works on the other. Various devices have been proposed by engineers to remedy this defect of exposure to enfilading fire. Some have proposed raising a very high bonnet at the salient, to act as a traverse and limit the effect of a plunging enfilade. Others have proposed a curved pan-coupé in the salient, of sufficient size to mount several guns to fire in the direction of the capital. Others suggest breaking the faces into several crochets, like the covered-way, and with like purpose. Others propose to draw the salient of the parapet so far inwards that the faces prolonged will fall without the limits of the assailant's enfilading positions. Others propose to occupy the salient with a high casemated traverse, to cover from enfilade and to give a strong fire from the casemates on the assailant's approaches in advance of the salients of the adjacent works. See *Outworks* and *Ravelin*.

DEMI-LUNE CUT.—This cut isolates the part of the demi-lune near the extremity of the face from the salient portion; this part, being arranged with a parapet behind the cut, can be defended after the enemy has effected a lodgment on the demi-lune salient. The cut thus prevents the enemy from driving the besieged from the redoubt of the re-entering place-of-arms; which he might do were the whole demi-lune to fall at once into his possession. By placing the interior line of the bottom of the cut sufficiently above the bottom of the ditch, the scarp of the demi-lune redoubt may be partly covered, and at the same time an obstacle may be placed in the way of an enemy who might attempt to carry the work behind the cut by first getting into the cut. The slope given to the bottom of the cut still leaves a height between the exterior line and the bottom of the demi-lune ditch which will secure the cut from an assault on that side. The object of this slope is chiefly so to diminish the height of the demi-lune scarp that it may not be exposed to a battery, which can be placed on the glacis of the re-entering place-of-arms. As to the interior crest, it is placed as low as possible, and is arranged to cover the interior from the plunging fire of the enemy when established on the demi-lune salient. See *Bastion-face Cut*.

DEMI-LUNE REDOUBT.—The essential object of this redoubt is to sweep at close range the terre-plein of the demi-lune and to render its defense more obstinate by the support it receives from the redoubt. The enemy having possession of the demi-lune will be obliged to carry its redoubt before he can assault the breach he may have made in the bastion-face, as this breach is seen in reverse by the fire of the flanks of this work. The redoubt should be as advanced as possible, to see in reverse the lodgments of the enemy on the glacis of the collateral works. The face of the redoubt is directed on the interior shoulder-angle of the bastion to have its ditch flanked by the bastion-face. In placing the salient of the magistral below the salient of the demi-lune, the top of the scarp-wall will be nearly on the level with the demi-lune terre-plein. This arrangement will force an enemy, lodged on the demi-lune terre-plein, either to lower his battery to effect a breach in the redoubt, or else to employ a mine for this purpose; either of which operations will cost him much labor and loss of time. The least command should be given to the redoubt over the demi-lune, to enable the fire of the redoubt to sweep the demi-lune terre plein. The flanks of the redoubt are principally to procure a reverse fire on the breach in the bastion-faces; their length is estimated for three guns. The piece nearest the extremity of one flank should be covered by the extremity of the opposite flank from the reverse fire which might come through the redoubt-gorge from the enemy's lodgment on the bastion covered-way. The terre-plein of the flank is made 11 yards, as it is habitually armed with cannon. The scarp-wall of the redoubt may be reduced to the minimum dimensions of 12 feet. But on account of its importance, and also not to diminish too much the interior space, it has been found that the dimensions adopted, 16.50 feet, best satisfy the requisite conditions. The top of the wall slopes towards the gorge, so that at the shoulder-angle it may be about 4 feet lower than at the salient; the object of this is to expose as small a portion of the wall as possible to the enemy's fire through the demi-lune cut; which from its width might admit of a breach being made in the redoubt, through it, from the enemy's lodgment on the re-entering place-of-arms. The dimensions named are employed in the Noizet system of fortification. See *Demi-lune.*

DEMI-PARALLELS.—In siege operations it is usual to place the third parallel so near to the defenses as to bring the covered-ways, or other most advanced defenses which may be assaulted openly, within range of stone mortars, placed in batteries either within or in front of this parallel; its position, for this object, should be some 60 yards from the salient points of the most advanced portions of the defenses, so as to bring their interior within the range of the stones and other missiles thrown from the mortars. In giving the third parallel this position, there will be a wide zone of ground between it and the second parallel, over which the approaches connecting these two parallels must be run, which would be very much exposed to the sorties of the besieged, as well as the third parallel, were its protection left to troops stationed as a guard in the second parallel. To provide protection for these approaches and for the third parallel whilst in process of construction, ends of trenches, termed *demi-parallels*, are run out on the right and left of the lines of the approaches, far enough to contain sufficient bodies of troops to protect the men working on the trenches in advance of them from sorties. The positions of the demi-parallels will be regulated by the same tactical considerations as those which regulate the positions of the parallels. The length to which they should be extended on the flanks of the approach will be regulated by the number of troops that it may be deemed necessary to post within them, and also from the consideration that they shall not obstruct or be endangered by the fire of any batteries to their rear.

DEMI-PIKE.—A kind of spontoon, seven feet long, used by the infantry or for boarding.

DEMI-PLACE D'ARMES.—In fortification, a circular trench constructed upon the prolongation of the lines of the covered-way, to the right and left of the zigzags, to cover the troops employed in their defense.

DEMI-REVETMENT.—A revetment of the scarf only to the height protected by the glacis.

DEMOLITION.—In military operations it sometimes becomes necessary to destroy buildings, bridges, etc. Wooden structures are very readily and effectually destroyed by burning. Ordinary dwelling-houses of stone or brick may be blown down by placing against the walls charges of from 25 to 50 pounds of powder, each contained in a bag, box, or any convenient vessel, and exploded by means of an electric primer, a slow-burning time-fuse, or a piece of slow-match. The effect of the explosion is to blow away a portion of the foot of the wall, that above settling down without, as a rule, toppling over. An inside angle or corner of the building is the most advantageous place for the charge, for the reason that, being confined on two sides, the explosive force acts more powerfully than when against a plain surface, and also because the angle or corner of the building, being a point of greatest support, when blown away leaves the remaining parts greatly weakened. Against strong and massive walls, such as are generally found in large public edifices, charges of powder, unless very heavy, have but little effect when simply exploded against the wall without tamping. Inside angles should, if possible, be taken, or when the building has buttresses, the angles formed by them are advantageous for confining the explosive force and causing it to take effect on the wall. The powder is placed in a box or keg and covered with earth and stones. When placed five or six feet above the foot of the wall the effect is greatly increased. In all cases where demolition is to be produced, dynamite may well be used instead of gunpowder. Its destructive effect is more than thirty times that of powder, weight for weight.

To destroy the arches of a masonry bridge, excavate a hole down to the crown or haunch of the arch, place in it a charge of one or two hundred pounds of powder, according to the thickness of the arch, tamp it well with earth and stones, and explode it. The amount of powder is determined from the formula $X = \frac{3}{4}A^2 \times B$: in which X is the charge in pounds, A the line of least resistance through the arch, and B the breadth of the bridge, both in feet. When the width of the arch is over 25 feet, two charges should be placed, to prevent the chance of blowing a hole through the middle without bringing down the sides. These should be exploded simultaneously, if possible. When the side walls are lightly built, it is better to pull enough of the stone away to allow a tunnel being run on top of the arch to the middle of the roadway. This does not interfere with the use of the bridge during the operation, and if it is not desired to destroy the bridge immediately, the charge may be kept in its place ready for use at any moment. In this case the charge should be in a tight box or barrel, well pitched to protect it against moisture. The charge may be exploded by means of an electric primer, the ordinary fuse used in blasting, or with a powder-hose. This latter is made of canvas or any stuff that will hold fine-grained powder, and is inclosed in a trough to protect it from the moisture of the earth.

Wooden bridges are easily burnt; but if great secrecy is necessary, a hole may be bored with an auger in a main-brace and a charge of powder or dynamite exploded therein, blowing it to pieces. Charges should be placed in several of the braces and exploded as near simultaneously as possible. During the War of the Rebellion a small torpedo was devised for this purpose. It consisted of a tin cylinder 1.75 inch in diameter and about 7 inches long. Both ends of the cylinder were open, and through it passed a bolt of .75-inch iron, with a stout head at one end and a nut at the other, each having a diameter of 2 inches. A washer of the same size as the head was placed under the nut; through a hole in the washer passed a strand of slow-match to communicate fire to the powder with which the cylinder was filled. A coat of varnish protected the powder from moisture. To use it, a hole 2 inches in diameter was bored in the timber; into this the torpedo was driven, head downwards, and the fuse ignited. The most effectual way of destroying an iron bridge is to attack the abutments by mining down so as to get behind the masonry a large charge of powder or dynamite, which being exploded destroys the supports of the superstructure. When time and means permit, remove as many bolts as possible, so as to weaken the parts, after which build a strong fire and heat the main-braces to make the bridge sag and warp out of shape, or to come down entirely.

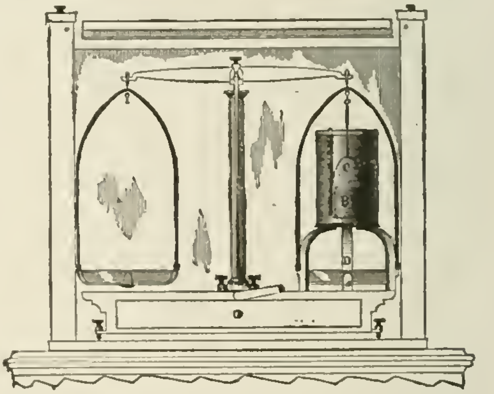
Canals may be temporarily disabled by cutting embankments. The most effectual way, however, is to blow up a lock, which may be done by digging down behind a facing wall and placing against it a charge of two or three hundred pounds of powder or a few pounds of dynamite, tamping well and exploding it. A lock destroyed in this manner requires a long time to repair. The arches of an aqueduct may be broken by drilling holes and blasting. An army depending upon a railroad for its supplies should be provided with an organized Construction Corps, fully equipped with every means for making speedy repairs. Damages done to railroads are easily repaired, in comparison with those done to canals.

DEMOLITION OF ARTILLERY.—The destruction of ordnance by artificial or other means. This is performed, if the gun is an iron one, by half filling the piece with powder, and jamming in one or two shot with stones, bits of iron, etc.; over this a complete tamping with stones and earth till the bore is filled. To break off the trunnions is not always an infallible mode of destroying ordnance, as they can still be fired from the ground. When time admits of only partially crippling guns by removing one of the trunnions, it is best done by laying the end of the trunnion on a block of wood, the blow being given by a sledge-hammer, or (if that be not at hand) by heavy shot. A gun may be destroyed by firing a shot at it behind one of the trunnions, which, if it should not break it, would render it unsafe. The first method, however, particularly if the muzzle is partly buried in the ground, will be found certain to burst the gun. To render bronze guns unserviceable, fire a shot into them from some other piece, behind the trunnions, which will prevent the possibility of their being used again. See *Demolition*.

DEMONSTRATION.—In military operations, an apparent movement or maneuver the chief object of which is to deceive the enemy and induce him to divide his force, as if to meet dangers from various quarters. When thus divided and weakened, he may be attacked with greater chance of success.

DENONCIATEUR.—In a general sense, a person not improperly called a military informer. So rigid indeed were the regulations (even in the most corrupt state of the French Government) against every species of misapplication and embezzlement, that if a private dragoon gave information to the Commissary of Musters of a troop-horse that had passed muster, having been used in the private service of an officer, he was not only entitled to his discharge, but received, moreover, 100 livres in cash, and became master of the horse and equipage, with which he retired unmolested. The officer was summarily dealt with.

DENSIMETER.—This instrument, employed in the determination of the specific gravities of metals for cannon, is simply a form of the hydrostatic balance, and was adopted in place of the hydrometer, formerly in use, in order to substitute a more expeditious process for the slow and tedious operation by the latter. The instrument consists of a delicate beam-scale, A, having suspended from one extremity of the beam a brass bucket, B, the bottom of which is perforated with holes. Underneath the bucket, and resting on a tripod, D—which stands over the scale-pan in such a manner as not to interfere with either the movement of the balance or working with the pan—is a glass jar, C, to contain water for the immersion of the bucket and specimen. A mark is scratched upon the jar near the top, and this mark indicates the height at which the water should, after the immersion of the bucket, always stand previous to an experiment. The immersion of the specimen causes the water to rise above this mark, immersing an additional portion of the stem of the bucket, and the latter loses, in consequence, a slight portion of its weight in reference to the beam. A correction, therefore, becomes necessary to compensate for this apparent loss in weight. To determine this correction, the bucket-stem is graduated in the following manner: The beam having been thrown into action, and the immersed bucket balanced by weights in the pan attached to the opposite arm, a mark is made upon the stem of the bucket where it is intersected by the surface of the water. The height of the water in the jar is then raised till as much more of the stem is immersed as is likely ever to be the case in practice. Another mark is then made where the stem is now intersected by the water, and the loss of weight in the bucket ascertained. The loss in weight, for the maximum immersion of the stem, amounts to only one tenth of a grain, while the corresponding length of stem is nearly one inch; the space between the marks, therefore, may be readily subdivided into tenths, and the necessary corrections can thus be read off the stem in actual weight to the nearest tenth of a grain. By using simply a thread in place of the bucket, the above correction might be neglected; but the greater convenience offered by the latter has led to its final adoption. A thermometer is suspended from the upper edge of the jar, as shown in the drawing.



The process, with this instrument, of taking the specific gravity of a specimen of metal naturally suggests itself. The jar being filled with water to the fixed mark, and the bucket suspended therein, the beam is thrown into action, and the weight of the immersed bucket ascertained by means of weights placed in the opposite scale-pan. This weight being noted for different temperatures can be tabulated, and thus become a known element for all calculations of the specific gravity with this instrument. The specimen of metal is then placed in the pan underneath the jar, and weights added to the other pan till the balance of the beam is restored. The sum of these weights is the weight of the specimen in air plus the weight of the bucket in water. The specimen is now transferred from the pan to the bucket, and replaced by weights in the pan underneath the jar, till the equilibrium is again established. The sum of these latter weights is the weight of the volume of water displaced by the specimen plus the weight lost in the bucket due to the immersion of an additional portion of its stem. The loss in weight is read off the bucket-stem in tenths of a grain, and is to be subtracted from the weights in the pan underneath. Denote the weight

DENMARK
WITH SCHLESWIG-HOLSTEIN.
SCALE OF MILES
Railroads
FÆR-OER
FAROE ISLANDS
ICELAND
BORNHOLM
SKAGER RACK
CATTEGAT
NORTH SEA
BALTIC SEA
SWEDEN
PRUSSIA
MECKLENBURG
HANOVER
ZEALAND
FUNEN
LAALAND
JUTLAND
SCHLESWIG
HOLSTEIN
AALBORG
RANDERS
RINGKIOBING
THISTED
HIORRING
SKANDERBORG
LAUENBURG
KIEL BAY
LITTLE BELT
ANHOLT ID.
LAESSO
AEROE
FEMERN ID.
MOEN ID.
SYLT ID.
ROMÖE
FOHR ID.
HELIGOLAND
Longitude East of Greenwich

of the bucket in water, as first determined, by a; the same weight of bucket and the weight of the specimen in air by b; the weight requisite to restore the equipoise after immersion of the specimen by c; the loss of weight in the bucket by d, and the correction for temperature by t. Then designating by D the specific gravity of the metal tested,

$$D = \frac{(b-a)}{c-d}\,t.$$

The following is the form of the record of computation:

Specimen.	Weights.				Temperature of water.	Logarithms corresponding to—			$e+h-f$.	Density.
	Bucket in water.	Specimen in air $+a$.	Specimen in water $+a$.	Loss in bucket.		$b-a$.	$c-d$.	Weight of water at observed temperature.		
	a	b	c	d		e	f	h		
Steel..................	877	6428	817.25	0.25	77°	3.8080759	2.9122225	1.9992771	.8951309	7.8548

See *Dupont de Nemours Densimeter* and *Mercury Densimeter*.

DENSITY.—When of two bodies of equal bulk or volume the one contains more matter than the other, it is said to have greater density than that other. The quantity of matter is measured by the weight, and thus density and specific gravity come to be proportional to one another. Platina, which is about 21 times the weight of water, long passed for the densest body; but Breithaupt of Freiburg, in 1833, made out *iridium* to be twice as dense. Rare is opposed to dense, and the rarest body known is *hydrogen*, which is about 14½ times rarer than atmospheric air. The density of bodies is diminished by heat and increased by cold. In the manufacture of gunpowder it is very necessary to attend to the density, as so much depends upon this all-important point in regulating the uniformity, time of burning, and strength of the powder. Experience has shown the density most likely, under certain circumstances, to produce a good result in the different natures of powder manufactured, both as regards their action upon the velocity of the shot and the pressure upon the gun. A large-grained dense powder burns slower than a small-grained powder of low density, and tends to preserve the gun better, as it does not throw such a strain upon it; hence the reason that large-grained and dense powder is used with all large ordnance. See *Gunpowder*.

DEPARTMENT COMMANDER.—An officer assimilated to the Commander of a separate army, with the same powers and duties in similar cases over all the troops within the limits of the Department. He derives his authority to command from the highest power of the Government. In the United States, certain duties of the Department Commander are defined by statute. He can convene Courts-Martial, and his action is final on all cases tried by such Courts, except in the case of a General Officer, or where the sentence of the Court extends to the loss of life or the dismissal of a Commissioned Officer. In time of war he is authorized to execute the death-penalty in cases of persons convicted as spies, mutineers, deserters, or murderers, and in cases of guerrilla marauders convicted in time of war of robbery, burglary, arson, rape, assault with intent to commit rape, or violation of the laws of war. See *Geographical Departments and Divisions* and *Military Department*.

DEPARTMENT OF ARTILLERY STUDIES.—A Department at Woolwich, for advanced scientific instruction, and for the instruction of officers generally, in *matériel* and kindred subjects.

DEPARTMENT OF THE DIRECTOR OF ARTILLERY STORES.—In the British service, a Department charged with the regulation of armaments and the introduction of new *matériel;* also the superintendence of the manufacture of warlike stores.

DEPARTMENT OF WAR.—"There shall be an Executive Department, to be denominated the Department of War; and there shall be a principal officer therein, to be called the Secretary for the Department of War. He is to perform and execute such duties as shall, from time to time, be enjoined on or intrusted to him by the President of the United States, agreeably to the Constitution, relative to military commissions, or to the land forces or warlike stores of the United States, or such other matters respecting military affairs as the President of the United States shall assign to said Department. And furthermore, that the said principal officer shall conduct the business of the said Department in such manner as the President of the United States shall, from time to time, order or instruct. That there shall be in said Department an inferior officer, to be appointed by the said principal officer, to be employed therein as he shall deem proper, and to be called the Chief Clerk in the Department of War, and who, whenever the said principal officer shall be removed from office by the President of the United States, or in any other case of vacancy, shall, during such vacancy, have the charge and custody of all records, books, and papers appertaining to said Department. The said principal officer, and every other person to be appointed or employed in said Department, shall, before he enters on the execution of his office or employment, take an oath or affirmation well and faithfully to execute the trust committed to him." (Act Aug. 7, 1789.) It seems impossible to read this Act of Congress, and contend that officers of the army are a portion of the War Department. And the statute-book will be searched in vain to find authority given to the Secretary over any officers other than officers of Staff Departments, or over subjects disconnected with the custody of public records, the support and supply of troops, the manufacture and care of warlike stores, the keeping of exact and regular returns of all the forces of the United States, or other kindred administrative matters, such as receiving the proceedings of Courts-Martial and laying them before the President of the United States for his approval or disapproval, and orders in the case. There is no Act of Congress which authorizes the Secretary of War to command the troops, and he being no part of the army, the President, of course, cannot authorize him to do so. But the Secretary of War is the regular constitutional organ of the President for the administration of the military establishment of the nation; and rules and orders publicly promulgated through him must be received as the acts of the Executive, and as such are binding upon all within the sphere of his legal and constitutional authority.

By an Act of Congress approved March 3, 1813, it is provided: That it shall be the duty of the Secretary of War, and he is hereby authorized, to prepare general regulations, better defining and prescribing the respective duties and powers of the several officers in the Adjutant General, Inspector General, Quartermaster General, and Commissary of Ordnance Departments, of the Topographical Engineers, of the Aids of Generals, and generally of the General and Regimental Staff; which regulation, when approved by the President of the United States, shall be respected and obeyed, until altered or revoked by the same authority. Here was a partial delegation of legislative power; and under this power of legislation so confined to the several Staff Departments, the Secretary of War, with the approval of the President, established Bureaus of the War Department, making the head of each Staff Department Chief of a Bureau, in all fiscal and administrative matters connected with his particular Department under the general direction of the Secretary of War. The War Department thus centralized all army administration, and efforts have since been made to centralize in the same way the command and government and regulation of the army. But as the old 62d Article of War declares that when different corps come together the officer highest in rank shall command the whole and give orders for what is needful to the service, unless otherwise specially directed by the President of the United States, according to the nature of the case, while the 61st Article gives the command to the senior regimental officer within his regiment, when other troops are not present, such centralization, if not a violation of law, would be a violation of all military principles, destructive alike to discipline and military spirit. For commands given immediately by the highest authority cause agitation rather than action. The superior authority becomes weakened in proportion as the eye becomes accustomed to it. Fear of it ceases, and when the highest authority habituates itself to doing everything, as soon as it ceases to be sufficient to do all there is nothing done. All degrees of rank and command have their degree of importance. Authority must regularly ascend and descend. Every inferior grade is the lieutenant of its superior grade, even to the oldest soldier, who replaces the corporal. Obedience is reciprocal to authority. Rules established by Congress, defining the rights, powers, and duties of all officers and soldiers, are much needed. See *Secretary of War* and *War Department*.

DEPENSES.—A term used in a military sense to imply secret-service money.

DEPLOYMENTS.—A general term for tactical maneuvers by which the front is extended. The following points are general: *On first or last company*—all companies except the designated company go to right or left, as the Major may command. If to the *right*, the point of rest is the *left* of the line; if to the *left*, the point of rest is the *right* of the line. *If on an interior company*, and the Major commands, "*Fours right and left*," the *front* companies go to *right*, and *rear* companies go to *left*, and point of rest is the *left* of designated company, if the command be, "*Fours left and right*," the front companies go to *left*, and *rear* companies go to *right*, and point of rest is the *right* of the designated company. In all cases companies are dressed toward the *point of rest*.

DEPORTATION.—The forcible removal of a people from their country; in former times employed as a means of securing the fruits of conquest. In the Scriptures it is recorded that not only the Jews but other peoples were carried away captives. Banishment is still a method of punishing political offenders in France and some other countries.

DEPOSITION—The testimony of a witness set down in writing. Depositions are taken either by a Judge or by a Commissioner specially appointed by him for that purpose. The questions to which the depositions are answers are usually put by the legal representatives of the parties to the suit, under the control of the Court or Commissioner, and the answers are taken down by the Clerk of Court, or by a Clerk specially appointed for the purpose. If the competency of the questions or the admissibility of the witnesses be objected to, the objection must be stated to the Court or Commissioner. The latter may either dispose of the objection at the time, or reserve it for the opinion of the Court by which he was appointed. It is a rule in the laws of evidence of all countries that the deposition cannot be read where the witness might be himself produced, because his oral testimony is the best evidence, and secondary evidence is never admissible. Where he is dead, however, or insane, or beyond the jurisdiction of the Court, his deposition then becomes the best evidence and may be read in Court.

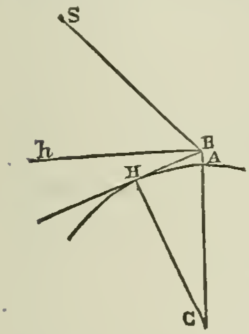
DEPOSITS.—Soldiers may deposit with the Paymaster any portion of their savings, in sums not less than five dollars, the same to remain so deposited until final payment on discharge. The Paymaster furnishes each depositor with a deposit-book, in which each deposit made is entered in the form of a certificate, signed by the Paymaster and the Company Commander, setting forth the date, place, and amount (in words and figures) of deposit, and the name of soldier making same. The attention of enlisted men should be called to the importance of preserving deposit-books as the only certain means of insuring absolutely correct repayment without delay. On the death of a soldier, account should be made of each deposit in the inventory of his effects, and on the accompanying final statements with which his deposit-book will be filed. The separate and accurate statement, by date and amount, of each deposit is absolutely essential to the correct calculation of interest. For any sums not less than fifty dollars deposited for the period of six months or longer, the soldier, on his final discharge, is paid interest at the rate of 4 per cent per annum. Deposits and interest thereon are forfeited by desertion, but are wholly exempt from forfeiture by sentence of Court-Martial and from liability for the soldier's debts.

DÉPOT.—In military matters, a name sometimes given to a place where army stores are deposited during war. In the English Regimental System, however, a depot used to be the town or barrack where certain stores belonging to the regiment were kept, as well as the regimental books and some of the men, when the regiment was ordered on foreign service. It was rarely that a whole regiment was engaged in active service at once; either one or two companies were generally kept at home, under the command of one of the officers, and were called *Depot Companies*. They formed a nucleus where recruits were received and drilled, and where the corporate existence of the regiment might be kept up. By the Military Forces Localization Act of 1872, under which the United Kingdom is divided into seventy sub-districts, every battalion, whether at home or abroad, has a depot of two companies. The depots of two battalions constitute the depot-center, or sub-district brigade, to which the volunteers and militia of the sub-district are affiliated. In time of war the depot would expand into a third battalion.

DEPRESSED GUN.—Any piece of ordnance having its mouth depressed below the horizontal line.

DEPRESSING-CARRIAGES.—These carriages permit the gun to fire over a parapet in the usual manner, and upon recoil allow the piece to descend behind the parapet, where it can be reloaded in safety. Various plans for effecting this have been proposed, but none actually adopted, in the United States service. The King carriage, mounting a 15-inch gun, has, however, been tested and found to work efficiently. This consists in lowering the rear end of the chassis until it nearly touches the ground, thus forming an inclined plane at an angle of about 30° to the horizon. The top-carriage is attached to a counterpoise by a band composed of wire ropes. This counterpoise is a heavy mass of metal descending into a well in front of the pintle. The carriage that has been adopted, and hereafter to be furnished for the barbette service, has an increase of 15 inches in height over those of old pattern. This modification is effected by inserting sections, similar in construction to the chassis-rail, between the rails and feet, props, and fork of the low chassis. The increase of height thus gained admits of a corresponding depression of the terre-plein, and consequently greater protection behind the parapet for the cannoneers. The gun, nevertheless, is exposed as before. Depressing-carriages are intended to protect the piece and carriage as well as the cannoneers. The accuracy of modern artillery-fire increases the danger to the guns with which a work is armed; and the disabling of a piece by the enemy's fire is of greater moment now than formerly, when works were garnished with a greater number, and of such small size as to be readily replaced when injured.

DEPRESSION.—1. The pointing of any piece of ordnance so that its shot may be projected short of the point-blank. 2. The *dip of the horizon*, or the angle through which the horizon appears depressed in consequence of the elevation of the spectator. Let



A be a point on the surface of the earth, and B a point situated in a vertical line from A. Let BH be a tangent to the earth's surface drawn from B. Bh a line in the same vertical plane perpendicular to AB. The angle hBH is the *true* dip of the horizon to a spectator at B. The true dip measured in minutes is equal to the distance in nautical miles of the visible horizon. Let C be the center of curvature of the surface; then, since CHB is a right angle, the angle $h\text{BH} = \text{HCA}$, and the minutes in this angle are the nautical miles in the arc AH. To find this angle in minutes or nautical miles, the rule is: Multiply the square root of the height in feet by 1.063. The true dip of the horizon, however, is not exactly the same as its apparent depression. The apparent sea-horizon is raised above its true place by *refraction* through an angle, which varies according to the state of the atmosphere and the relative temperatures of the air and water, the variation ranging from one third to one twenty-third of the amount of the true dip. The rule commonly employed is to diminish the true dip by about one fourteenth of its amount, to find the apparent dip. If S be a star or the sun in the same vertical plane with ABH, and an observation of the altitude above the sea-horizon be made by means of a sextant from the point B, the apparent dip of the horizon must be subtracted from the observed angle, in order to find the altitude of the sun. Owing to the uncertainty of the amount of refraction, the nearest minute to the dip given in the tables is usually taken. The following table gives a sample of the amount of the apparent dip under ordinary state of the atmosphere and equal temperature of air and water:

Height. Feet.	Dip. m. s.	Height. Feet.	Dip. m. s.
0	0 0	8	2 50
1	1 0	9	3 0
2	1 20	10	3 10
3	1 40	20	4 20
4	2 0	30	5 20
5	2 10	40	6 10
6	2 20	50	7 0
7	2 40	100	9 50

DEPTH.—A technical word peculiarly applicable to bodies of men drawn up in line or column. The depth of a battalion or a squadron is the number of men in rank and file from front to rear.

DEPUTY ADJUTANT GENERAL'S DEPARTMENT.—In the British service, a Department charged (under the Commander-in-Chief) with the discipline, promotion, and distribution of brigades.

DEPUTY ASSISTANT ADJUTANT GENERAL.—In the British service, a subordinate officer of the Adjutant General's Department, who performs similar duties to those of an Assistant Adjutant General. In the field, a Deputy Assistant Adjutant General is attached to each division.

DEPUTY MARSHAL.—In the British service, the senior Sergeant Major of each regiment of Foot-guards, who sees after and makes out the routes of deserters, and receives an allowance for so doing.

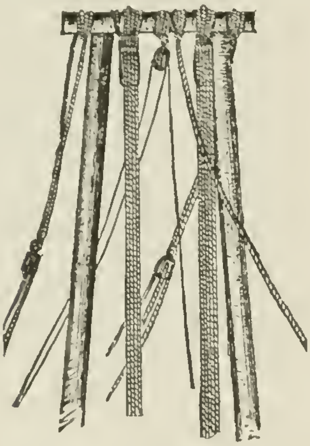
DERASER.—A term meaning to cut off the superfluous clay from a gun-mold previous to its being placed in the pit. See *Casting* and *Mold*.

DERIVATION.—Derivation, or drift, is the deviation peculiar to rifle-projectiles, the divergence being on the side towards which the grooves *twist*. It is a constantly increasing divergence from the plane of fire, and is allowed for, in aiming, by means of a lateral motion given to the rear sight. See *Drift*.

DERRICK.—The derrick is a machine used for hoisting or lowering heavy bodies to or from the top of vertical walls or similar places. It usually consists of one spar or leg; but the one employed for raising 15-inch guns consists of two legs made of round spars of yellow pine, 29 feet long, 11 inches diameter at the foot and 9 inches at the top; one sill, half round, 16 feet long and 11 inches in diameter; one cap, half round, 8 feet long and 9 inches in diameter; two iron straps, with keys and wedges for securing cap to legs. Near each end of the sill, on the square side, is a mortise, into which fits the tenon on the foot of the leg. The cap is similarly mortised to receive the top of the legs, and is held fast in this position by the straps fitting over it and keyed through the legs.

The derrick will be readily understood by noticing its action when raising a 15-inch gun. To perform this work, it is put together on top of the rampart (or other place to which the gun is to be raised); the sill is about five feet from the edge of the wall; the main-tackle upper block is lashed to the cap near one leg, and the muzzle-tackle upper block near the other leg. The ends of the guys are hitched to the ends of the cap; the middle laid across the legs, and a half-hitch taken over each end, thus doubling them; a stout thimble is placed in the bight of each, into which the guy-tackles are hooked. Secure holdfasts must be obtained for the guys; to these the guy-straps are attached, and in the bight of each a stout thimble is placed, into which the guy-tackle is hooked. One end of the fore guy is attached to the middle of the cap by a round turn and two half-hitches, the end being securely stoppered to the guy. A luff-tackle purchase is applied to the fore guy and its holdfast, and by means of this the derrick is raised to a vertical position. The sill is firmly secured, with stakes or by bracing with skids, against some fixed object. The girtline is attached to the cap by a strap, and having been raised with the derrick, a man is sent up by it, who, by the same means, receives the leading blocks, which he secures to the cap by means of straps. The main-tackle fall is next rove through the blocks, and the lower block lashed to the gun 2 feet 6 inches in *rear* of the axis of the trunnions. The muzzle-tackle fall is rove, and the lower block lashed 3 feet in *front* of the axis of the trunnions. These blocks are each lashed to the gun by seven turns with the lower-block lashing, the lashing being frapped on each side of the blocks with its ends. Two snatch-blocks are attached to the sill, one near the foot of each leg, by strong straps. These straps should be laid on the ground under the sill previous to raising the derrick, and if the ground is gravelly they should be protected from chafing by a canvas laid under them. Through these snatch-blocks the main and muzzle tackle falls are severally led, each to one of the capstans. The capstans are manned by sixteen men each. A strain is brought upon the falls, and the guy-tackles hauled upon until the head of the derrick is almost vertically over the edge of the wall. The capstans are worked and the gun is hoisted, care being observed to work the capstans so as to keep the piece in a horizontal position. One or more shifting-planks are let down by ropes against the side of the wall to prevent the gun from chafing against it and to ease it over the coping. When the gun reaches the top of the coping, preventer-tackles are hooked to straps around the breech and muzzle. When the piece is sufficiently high, the guy luff-tackles are hauled upon and the piece landed on cribs or blocks. The preventer-tackles are likewise used to assist in bringing in the piece and landing it in a proper position. If it is desired to place the gun on the cradle, the falls are slacked off and the sill of the derrick moved far enough back to admit the cradle. The gun is again raised and landed in its bed on the cradle. The derrick should not be allowed to assume an inclination of less than four on one.

To lower the gun, the piece is brought to the edge of the wall on the cradle; the derrick is erected over



it; the gun-sling and the tackling are attached, all in the manner explained for hoisting; the capstans are worked; the piece lifted and eased to near the edge of the wall by the preventer-tackles. The cap of the derrick having been placed directly over the piece, the strain will increase its inclination sufficiently to allow the gun to be eased to the edge of the wall. In this position the piece is allowed to rest on blocks or skids, the cradle is removed, and the sill of the derrick moved up close to the gun. The gun is then hoisted, eased over the edge, and lowered to the foot of the wall. The derrick is dismantled in the inverse order in which it was put up. One capstan, if powerful enough, is sufficient for lowering or hoisting the gun, in which case the lower block is lashed to the piece at the center of gravity. The lashing is executed as before explained. The capstan usually issued to artillery posts is, however, not sufficiently powerful, and it will invariably require two of them. Care must be taken to keep the guys hauled upon so that the cap and sill remain always parallel to each other; the derrick is thus prevented from twisting. By omitting the cap and then lashing the heads of the spars together with shear lashing, the derrick may be used as shears. In this case, only the main tackle can be used. When spars can be procured of sufficient length to construct shears high enough, it is best to place the shears at the foot of the wall instead of on the top. The shears should be not less than 20 feet higher than the wall. This method permits the piece to be raised and eased over to the terre-plein with less inclination, and consequently less strain upon the legs of the shears and on the guys. See *Capstan*, *Gin*, and *Mechanical Maneuvers*.

DERRICK-CRANE.—A heavy crane for out-door use. Its construction is substantially identical with that of the jib-crane except that the head of the mast is supported by guy-rods, instead of by attachment to a roof or ceiling. This style of crane is built of capacities from 5 to 20 tons, and of any desired dimensions of mast and jib. The description of the jib-crane will apply to this crane also, all of their several parts being identical, except that in this case the mast is extended somewhat above the jib, and the upper bearing, in which the mast revolves, is supported laterally by guy-ropes, or rods, attached at their lower ends to suitable anchors in the ground, or to adjacent buildings. The motions of hoisting and lowering, and travel of the trolley on the jib, are all effected by means of the mechanism at the foot of the mast. By pushing or pulling the suspended load rotation of the crane is effected as easily as in the case of the ordinary jib-crane. This crane is adapted for use in foundry-yards, quarries, and on wharves, and can be substituted for the pillar-crane, where the guy-rods are not objectionable, or where there is difficulty in obtaining the foundation needed to support a pillar-crane. It can also be arranged for operation by power, or by direct steam. See *Cranes* and *Jib-crane*.

DESCEND.—A term, in a military sense, signifying to make an attack or incursion as if from a vantage-ground.

DESCENTS.—In fortification, the holes, vaults, and hollow places made by undermining the ground. The *descents into the ditch* are cuts and excavations made by means of saps in the counterscarp, beneath the covered-way. They are covered with thick boards and hurdles; and a certain quantity of earth is thrown upon the top in order to obviate the bad effects which might arise from shells, etc.

DESCRIPTIVE BOOK.—A company book in which *descriptive lists* of the soldiers are kept.

DESCRIPTIVE LIST.—A paper giving a brief history of the soldier, a description of his person, and the statement of his account. It accompanies him wherever he goes, being intrusted to his Detachment or Company Commander.

DESCRIPTIVE MEMOIR.—This memoir, which should always accompany a sketch of a topographical reconnoissance, is intended to convey that information relating to the natural features of the ground not expressed upon the sketch; to express that information for which there are no conventional signs; and to present those facts relative to the ground which become important by being considered in connection with the probable military operations to be undertaken.

DESERTER.—A soldier who forsakes his flag. In time of war such an act is punishable with death or otherwise as a Court-Martial may decide. In time of peace the punishment is comparatively light. Deserters from the American army, having entered the service of the enemy, suffer death if they fall again into the hands of the United States, whether by capture or being delivered up to the American army; and if a deserter from the enemy, having taken service in the army of the United States, is captured by the enemy and punished by them with death or otherwise, it is not a breach against the law and usages of war, requiring redress or retaliation.

DESERTION.—The crime of a man absconding, during the period for which he is enlisted, from the service. In England this crime was, by certain old statutes, made punishable with death; but now the punishment for desertion is prescribed by the annual Mutiny Acts. By these any Court-Martial may inflict a sentence of corporal punishment, not exceeding fifty lashes, for desertion, and may in addition award imprisonment for the period prescribed by the Articles of War. By 20 Vict. c. 13, s. 35, and 22 Vict. c. 4, s. 35, it is provided that deserters may be marked on the breast in gunpowder or ink with the letter D. This provision is omitted in the Mutiny Act, 1860. Recruits deserting before they have joined their regiments are to be taken to the regiment nearest to the place where they were found, but to suffer no punishment except loss of bounty. Inducing to desert was formerly punishable by death; the punishment has, by modern statutes, been commuted to penal servitude. If simply "absent without leave," a British soldier, besides undergoing some kind of punishment, forfeits his regular pay for the days of absence; but if his non-appearance involves actual desertion, he loses all claim to additional pay, good-conduct money, and pension. The number of deserters from the British army is very great. In one particular period of eight months it was found that no less than 8822 men deserted from the regular army, and 6614 men from the militia; in 1874, 7939 men deserted from the army; and in 1875, 5629. Many experienced officers attribute the evil to the temptations of bounty, rather than to any other cause; and advise that the same amount of money should be applied to the soldier's benefit in some other form.

In the United States, the President is authorized to drop from the rolls of the army for desertion any officer who is absent from duty three months without leave; and no officer so dropped shall be eligible for reappointment. And no officer in the military or naval service is in time of peace dismissed from service except upon and in pursuance of the sentence of a Court-Martial to that effect, or in commutation thereof. A reward of $30 is paid for the apprehension and delivery of a deserter to an officer of the army at the most convenient post or recruiting station. This reward includes the remuneration for all expenses incurred in apprehending, securing, and delivering the deserter. Rewards and expenses paid for apprehending a deserter are set against his pay on conviction by a Court-Martial of desertion, or upon his restoration to duty without trial on such condition. Where a soldier, for whose apprehension as a supposed deserter the reward of $30 has been paid, is brought to trial under a charge of desertion and acquitted, or convicted of absence without leave only, the amount of the reward is not stopped against his pay. Deserters make good the time lost by desertion, unless discharged by competent authority. They are considered as again in service upon return as deserters to military control. Deserters are brought to trial with the least practicable delay. While awaiting trial they receive only the clothing absolutely necessary, and no pay. Every deserter forfeits all pay and allowances due at the time of desertion. The authorized stoppages and fines due at the time of desertion are deducted from the arrears of pay. If the stoppages and fines are greater than the arrears of pay, the balance is deducted from pay due after apprehension.

Deserters from the enemy, after being examined, are secured for some days, as they may be spies in disguise; as opportunities offer they are sent to the rear; after which, if they are found lurking about the army, or attempting to return to the enemy, they are treated with severity. The arms and accouterments of deserters are turned over to the Ordnance Department, and their horses to the corps in want of them, after being branded with the letters "U. S." The compensation to be accorded to deserters for such objects is according to appraisement made under the direction of the Quartermaster's Department. The enlistment of deserters from the enemy, without express permission from General Headquarters, is prohibited. Soldiers who may be discovered to be deserters from the Navy or Marine Corps are immediately dropped from the rolls of the army. In all such cases reports are forwarded with descriptive rolls to the Adjutant General's Office, and the men held without pay, awaiting instructions. This is not regarded as requiring the discharge of any man who may have been enlisted in the army after having received a discharge from the Navy or Marine Corps, the recruiting officer being in ignorance of the fact that he had deserted from either of those branches of the service; but whenever such fact of desertion becomes known, it will be regarded as a bar to enlistment in the army. In case, however, of such enlistments, no benefit can accrue to the soldier for previous time served in the army. Every person who entices or procures, or attempts or endeavors to entice or procure, any soldier in the military service of the United States, or who has been recruited for such service, to desert therefrom, or who aids any such soldier in deserting or attempting to desert from such service, or who harbors, conceals, protects, or assists any such soldier who may have deserted from such service, knowing him to have deserted therefrom, or who refuses to give up and deliver such soldier on the demand of any officer authorized to receive him, is punished by imprisonment for not less than six months nor more than two years, and by a fine not exceeding $500.

DESICCATION.—The expulsion of moisture from solid substances. This is effected at various temperatures, according to the nature of the substance, and by different means, such as the water-oven, air-bath, etc. The wood of fuses is thus treated.

DESPATCH.—An official document or letter penned by a Commander in the field to other authorities. The term is also applied to letters received from Governors of Colonies. All correspondence from Military Commanders to superior authority in the field, detailing their acts before the enemy, come under the head of despatches.

DETACH.—To separate for a special object or use; as to send out a body of men on some particular service, separate from that of the main body.

DETACHED BASTION.—In fortification, a bastion which is separated from the enceinte by a ditch.

DETACHED WORKS.—In fortification, the works that are situated beyond the range of fire of any other works, and which, for their security, have to rely upon their own strength and resources. The object of such works is to defend and hold isolated points that are of importance, such as railroad or other bridges, mountain-passes, narrow defiles, fords, points upon rivers, to close them against the passage of hostile vessels, etc. The character and extent of a work of this class will depend upon the degree of importance attached to the object for which it is constructed, the amount of force available for its occupancy, and the nature of the locality. In every instance

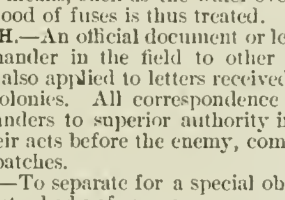


Fig. 1.

artillery would form an important element in its means of defense, and the position of the work should be selected so as to allow free use of it. Works of this kind may be classified under three heads: 1. Those which, being secure on the flanks and in the rear, are assailable only in front. Under this class may be placed open batteries located on the banks of rivers, or at the entrance of harbors, to prevent the passage of an enemy's vessels. 2. Those which are assailable in front and on the flanks, but not in rear. 3. Those which are assailable on all sides.

First Class.—This is applicable to narrow defiles where the flanks are secure against being turned. When the width of the defile is not greater than 1800 yards, the line may be a straight one (A B) for infantry, with short advanced lines on the flanks, as represented in the drawing (Fig. 1), for artillery. Should the conformation of the ground be not suitable for placing artillery precisely as represented in the drawing, then the most commanding position on some other part of the line will be selected for it, bearing in mind always to secure as far as possible cross-fire over the ground in front. When the defile exceeds 1800 yards in width, a *crémaillère* or *serrated* line is adopted, and on it the artillery is disposed as represented in Fig. 2.

Second Class.—The plan of works of the second class admits of great variety, depending on the extent of the position. The most simple is that of a work of only two faces, the salient being towards the assailant's line of approach. This work is termed a *redan.* The faces should receive such direction as to sweep the approaches to the flanks of the position. As

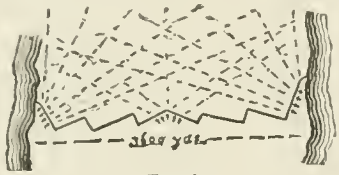


Fig. 2.

many pieces as possible are placed in the salient, and others disposed along the faces in the most commanding positions for sweeping the ground in their front. The angle formed at the salient by the faces should never be less than 60 . When the flank approaches extend somewhat to the rear, a flank is added to each face of the redan; it then becomes a *lunette.* The flanks receive such directions as will sweep by their fire that portion of the flank approaches which cannot be reached from the faces except by a very oblique fire. The artillery is placed in position at the salients, in each of which is a pan-coupée.

Third Class.—The works comprised in this class are termed inclosed works; as, being assailable on all sides, they must, for security, present a complete line throughout to any assault. These works may be divided into three orders: 1. *Polygonal works,* or *redoubts;* 2. *Tenailled works,* or *star-forts;* 3. *Bastioned works.* See *Field-fortification.*

DETACHMENT. — Detachments consist of small bodies of troops, composed of one or several arms, to which are intrusted some mission connected with the operations of the main body, but, for the most part, performed beyond the sphere of its support; such, for example, as the occupation of some post, or defile, which is to be held temporarily, as necessary to the movements of the main body; the surprise of a post held by the enemy; the seizure of a convoy, etc. The composition of a detachment will depend upon the nature of the duty to be performed; the character of the country in which it is to operate; the distance of the point to be reached; and the more or less celerity required in the operation. As a general rule, detachments should be formed only of light troops, well acquainted with their duties; and, in every case where it can be done, they should consist of a proper proportion of each arm of the service, if the duty upon which they are sent is at all of an important character. By this combination each arm is enabled to act with more boldness and vigor, from the support with which it will meet in the others, and can better select its moment for action, according to the character of the ground on which it finds itself. The combats of detachments will be mostly restricted to firing and the skillful employment of skirmishers. The troops must be kept perfectly in hand for mutual support, the artillery keeping near the infantry, and the cavalry, whenever the opportunity is presented, hazarding only short but vigorous charges against the enemy. The officer placed in command of a detachment should be thoroughly conversant with the handling of troops, so as to insure constant reciprocity of support, and to be able to seize upon those opportunities of bringing the proper arm into action, and for passing from the defensive to the offensive, which combats between small bodies of troops so frequently present.

As a detachment must rely mainly on its own resources, the *personnel* and *matériel* of the troops should be rigidly inspected before marching, to see that the men and horses are in a sound state; that nothing is wanting in their equipments; that the gun and other carriages are in good traveling order; and that the necessary amount of ammunition, provisions, and forage have been provided for the expedition. Every source of information should be consulted with respect to the nature of the roads and the country over which the column is to march; and good maps, telescopes, and guides should be provided. If a reconnaissance of the line of march has been directed, it should be placed in charge of a well-informed staff or other officer conversant with the duties required of him, so that the Commander of the detachment may be accurately informed of the state of the roads, as to their practicability for men, horses, and carriages; particularly the number of hours of march from station to station; and the character of the obstacles with which he may be liable to meet, from the state of the bridges, the nature of the water-courses, and the defiles along the route. In order to avoid being anticipated in our object by the enemy, every attention should be paid to preserve strict order among the troops, and to advance with celerity, so that secrecy may be kept until the detachment reaches its destination. The troops for this purpose should be kept as closely together as the character of the ground will permit; and when guides are employed they must be strictly watched, and not be dismissed until the march is completed. The distribution of troops, or the *order of march,* will mainly depend upon the character of the country; the general rule to be followed is so to place each arm in the column that the troops may be formed for action by the most prompt and simple movements. In a very open country the greater part of the cavalry will be at the head of the column; where it is somewhat broken, half of the cavalry may be in front, and the remainder in the rear; and in a very difficult country the infantry will lead. The artillery may be placed in the intervals of the column where the country is not difficult; in the contrary case it will be in the rear, but covered by a small detachment which it precedes.

The column must be secured from a sudden attack of the enemy by an advanced-guard, flankers, and a rear-guard. The advanced-guard will be composed of cavalry or infantry, or of the two combined, according to the character of the country. In some cases it may be well to have two or three light pieces with the advanced guard. The strength of the advanced-guard, for detachments not over two thousand men, need not be greater than one fifth of the whole; for larger bodies it may be between a fourth and a third, according to the degree of resistance it may be required to offer. The advanced-guard of a detachment should seldom leave a wider interval than about a thousand paces between it and the main body. In a broken country, when this force consists of infantry alone the distance should be less, to avoid an ambush. The main body of the advanced-guard should always be preceded a few hundred paces by a strong patrol of cavalry or infantry, to search the ground and secure the advanced-guard from falling into an ambush, or from a sudden attack. The flankers will consist mainly of a few detachments, which march parallel to the column and a few hundred paces from it, according to the character of the ground; these will throw out a few men, from a hundred to a hundred and fifty paces, on their exposed flank, to keep a vigilant lookout, in that direction, for the enemy. Occasional patrols may also be sent out on the flanks when it is deemed necessary to push an examination to some distant point, or to gain a height offering a commanding view of the country. As the object of the flankers is rather to give timely notice to the main body of an enemy's approach than to offer any serious resistance, the detachments of which they are composed need only consist of a few men. The rear-guard, except in a very broken or mountainous country, which would offer facilities to the enemy for slipping to the rear, need only be a small detachment, placed more to prevent stragglers from falling to the rear than for any other object. Night-marches should not be made, except in case of necessity. When their object is to surprise an enemy, if there be an advanced-guard, it should be kept near the head of the column. Patrols should be sent forward, with orders to advance with great caution and not push on too far. Flying patrols may, if requisite, be kept up on the flanks. The most exact order and silence should be maintained, and extreme vigilance be exercised to avoid placing the enemy on the alert.

DETAIL FOR DUTY.—A roster, or table, for the regular performance of duty either in camp or garrison. The general detail is regulated by the Adjutant General, according to the strength of the several corps. The Adjutant of each regiment superintends the detail of the officers and non-commissioned officers for duty, and the Orderly Sergeants detail the privates.

DETONATING-FUSE.—By a detonating-fuse, or detonator, is meant one that causes a detonating explosion. The ordinary method of producing explosion is by the direct application of flame. By the detonating method, explosion of the main charge is caused by the concussion exerted by a small charge of explosive material in the fuse. Fulminating-mercury seems to possess peculiar properties as a detonator, and practically is the only body so used. Detonating-fuses are used when violent shattering explosions are desired. Thus nitro-glycerine, gun-cotton, and their preparations are always fired by means of a fulminate exploder. The ignition of the fulminate may be accomplished in the ordinary manner, or by the use of electricity.

The simplest fulminate exploder is made by attaching a copper case or large cap containing the fulminate to the end of a piece of common running-fuse. If the fuse fits the cap closely it may be retained in place, and the cap protected against moisture by pressing round it wax, hard soap, or other similar substance. If the fuse is too small, it must be passed through a plug of wood or small cork fitting the cap, and the whole fastened on as above. Before it is fastened into the cap the end of the fuse must be spread out so as to insure contact with the fulminate. Fifteen grains is the usual amount of fulminate placed in the cap; it should be put in when wet, with some gummy solution or varnish, so that it will dry to a solid lump which will not shake loose. Even in exploding powder there is often great advantage in using detonating-fuses. It is difficult to prove that actual detonation of the powder is brought about, but experiment has shown that a much more violent action can be obtained by using this mode of firing. See *Detonation* and *Fuse*.

DETONATING POWDER.—One which explodes by a blow. The compound used in the priming of percussion-caps and fuses is the fulminate of mercury or of silver, collected as a precipitate when the metal, dissolved in nitric acid, is poured into warm alcohol. The precipitate is collected, washed, and dried.

DETONATING-PRIMER.—A primer exploded by a fuse, and used in blasting-operations to violently explode gun-cotton, instead of the former plan by which the charge of gun-cotton was simply ignited.

DETONATION.—The instantaneous explosion of the whole mass of a body. Thus, when gunpowder is fired in the usual manner, true combustion takes place, which goes on with comparative slowness from the surfaces of the grains toward their interiors. On the other hand, when nitro-glycerine is fired by means of fulminating-mercury, the whole mass explodes simultaneously, or very nearly so. Doubtless a certain time is always necessary; but with the so-called detonating explosives it can be practically neglected, and the explosion called instantaneous.

Some explosives seem to always detonate, no matter how fired (chloride of nitrogen, the fulminates, etc.), while others are detonated or not according to the method of firing (gun-cotton, gunpowder, etc.). Probably all explosives can be detonated if the right methods of doing so are known. Gun-cotton seems to have a greater range of susceptibility to different modes of firing than any other explosive agent. It can be made to burn slowly without explosion, and the rapidity of its action can be increased up to the detonating point. Nitro-glycerine always explodes powerfully, but its effect is much lessened when fired with gunpowder. Gunpowder, as ordinarily used, is, of course, not detonated, as the violent, sudden effects of detonation would be undesirable. For other purposes (e.g., torpedoes, etc.) it would be a great advantage if it could be made to give more violent explosive effects by a peculiar mode of firing. It has been demonstrated that this can be done, although the best mode of doing it, or whether detonation is actually accomplished, is not known. Probably a mechanical mixture like gunpowder can never be brought by any mode of firing to approach as near to a perfect detonation as the chemical substance nitro-glycerine or gun-cotton; but, even if not detonated, better effects for certain uses may be obtained from it if the proper means are used.

Detonation is produced by the application of the requisite concussive force by means of a detonating-fuse. A detonating-fuse is one which causes explosion by the blow or shock it gives, while the ordinary fuse usually ignites by simple inflammation. Detonating-fuses are generally charged with fulminating-mercury, a substance which seems to be specially adapted for this use. With such fuses are fired nitro-glycerine and its preparations and dry gun cotton. There seems to be for each explosive about a certain amount and kind of force required to effect detonation, which must not be materially departed from. If the fuse is too weak, inflammation or a feeble explosion only will result; if too heavily charged, it is more likely to scatter or disintegrate the material acted upon than to explode it. There is also a relation between the mass of the explosive and the charge of the detonating-fuse which must be observed. This relation is more marked with some explosives than with others. Thus, nitro-glycerine is a body easily detonated, and the same amount of fulminate seems to fire equally well all usual quantities. If a single particle is detonated, the action quickly extends through the whole mass. Other substances, less easily detonated, require that as the mass is increased the force applied shall be increased, so that all the particles shall receive a sufficient blow, otherwise only a part will be detonated.

In a detonation we have the fullest *explosive* effect. The suddenness of the explosion concentrates the blow, making it sharp and violent. For certain purposes this is much more effective than would be the same total amount of force more slowly exerted. For instance, in blasting hard rock the violent explosion will throw out and shatter much more rock proportionally than the slower explosion, which intends to escape in the direction of the least resistance. Therefore, in blasting with nitro-glycerine, for example, hard tamping is unnecessary. The explosion is too sudden to allow the gases to blow out the tamping and so escape. The effect is consequently equal in all directions. The advantages gained in blasting with nitro-glycerine and its preparations are so great that their use is constantly increasing, in spite of their high cost and the prejudice against them on account of the many accidents that have occurred with them. When a scattering, tearing effect is desired, the detonating explosive must be used. See *Detonating-fuse*, *Explosion*, and *Gunpowder*.

DEVASTATION.—In warfare, the act of destroying, laying waste, demolishing, or unpeopling towns, fortified places, etc.

DEVELOPMENT. — That process in photography which immediately follows exposure, and which renders the picture visible in all its details. It consists in the precipitation or deposition of *new material* on that portion of the sensitive surface which has been acted on by light; the same principle therefore prevails in all processes. This may be made clearer by reference to a few examples. In the daguerreotype process, an iodized silver plate, after exposure in the camera, is exposed to the vapor of mercury; the vapor adheres to those portions of the plate which have undergone a peculiar molecular change from the action of light, but not to those parts unacted on. The lights of the picture are therefore "developed," or "brought out," by the acquisition of *new material*, i.e., mercury. A collodion negative is similarly "brought out" by the precipitation, by means of a deoxidizing agent, such as pyrogallic acid, or protosulphate of iron, on the *actinized* portion of the plate, of *new material*, composed of metallic silver and organic matter. A similar change takes place in the chrysotype process, where the metallic salt with which the paper is impregnated is reduced to a state of protosalt, which reacts through the decomposition of water, and causes the precipitation of *new material*, in the form of finely divided metallic gold, on the parts where light has acted. Other processes might be cited, but these are deemed sufficient to illustrate the principle stated above.

DEVIATION OF PROJECTILES.—The term *deviation* must be understood to mean not only the deflections, right or left, of the line of fire, but also the differences between the ranges of similar projectiles fired under like condition from the same guns. Very great irregularities occur in the paths of spherical projectiles. If a number of projectiles be fired from the same gun, with equal charges and elevations, and with gunpowder of the same quality, the gun-carriage resting upon a platform, and the piece being pointed with the greatest care before each round, very few of the projectiles will range to the same distance; and, moreover, the greater part will be found to deflect considerably, unless the range be very short, to the right or left of the line in which the gun is pointed. With elongated projectiles the fire is far more accurate, but still the ranges and deflections are subject to variations of greater or less amount. The causes of the deviations of projectiles, whether fired from smooth-bore or rifled guns, and independent of inaccuracy in pointing, and variable position of the gun-carriage, are *wind*, *variable projectile force*, and *rotation of the earth*.

Should the wind be blowing in gusts and be changeable in direction, it is difficult to allow for it in pointing the gun; but with a steady breeze in a pretty constant direction, a few rounds will generally be sufficient to show the allowance necessary. The velocity of the wind is very low compared with that of the projectiles, but it remains usually nearly the same throughout its flight, whereas the velocity of the projectile decreases rapidly; it therefore frequently happens that the wind appears to have greater effect towards the end of the range, and it may be often noticed in practice that projectiles deviate in a rapidly increasing curved line. The wind, if strong, will greatly affect the ranges of projectiles; decreasing or increasing the range according as it may be blowing with or against the projectile. The lower the velocity of a projectile, the greater will be its deflection caused by the wind, as, for instance, upon mortar-shells, on which, having low velocities and long times of flight, the wind exercises a very disturbing influence. The greater the density of the projectile, the less will its motion, during flight, be affected by the wind; and thus shells are more influenced by wind than shot. The wind exercises a very great deflecting influence upon an elongated projectile during its flight, rendering it difficult to obtain accuracy of fire at long ranges, even from rifled guns, excepting in very calm weather. If the center of gravity be placed very near the center of the long axis, the force of the wind will be pretty evenly distributed over the whole length of the projectile. Should, however, the center of gravity be placed far in advance of or behind the center of figure, the force of the wind will press unequally upon the shot, and uncertain deflections will most probably occur.

It is impossible with our present facilities to manufacture large quantities of powder of a perfectly uniform quality; but supposing it could be accomplished, the force from a given charge would be liable to variation according to the state of the atmosphere, and the condition of the powder as affected by the time it has been in store; it will also be frequently found in practice that the charges have not been weighed out with perfect accuracy, nor the gun loaded so that the projectile is always in the same position with reference to the charge. The consequence is that very few projectiles fired from the same gun with what are called equal charges leave the bore with exactly the same initial velocity.

The deviation of a projectile caused by the rotation of the earth is a complicated problem. The principle that this rotation will impress upon the projectile a tendency, upon leaving the bore, to move with the same velocity in the same direction as the point upon the surface from which the gun is fired is readily comprehended, but not its application to some particular cases. The deviation due to this cause is too slight to be regarded in practice.

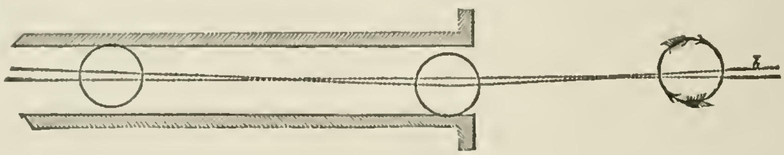


Fig. 1.

The line of sight may be improperly placed and situated out of the vertical plane, either in consequence of the construction of the gun or its carriage, or by the effect of the inclination of the plane upon which it is placed. In these two cases the line of fire maintaining a fixed and determined position, in respect to the axis of the gun and the vertical plane of fire, the deviations are constant for equal distances and equal inclinations, and it becomes easy to correct them after a few trials.

The barometric state of the atmosphere may also produce an effect upon the ranges; for the greater the density and elasticity of the displaced fluid, the greater will be the retardation of the projectile.

Spherical Projectiles.—The principal causes of the deviations of projectiles fired from smooth-bore guns are: 1st. Windage. 2d. The imperfect form and roughness of the surface of the projectile. 3d. Eccentricity of projectiles arising from their not being homogeneous.

Windage causes irregularity in the flight of a projectile, from the fact of the elastic gas acting in the first instance on the upper portion of the projectile and driving it against the bottom of the bore. The projectile reacts at the same time that it is impelled forward by the charge, and strikes the upper surface of the bore some distance in advance, and so on, by a succession of rebounds until it leaves the bore in an accidental direction and with a rotatory motion, depending chiefly upon the position of the last impact against the bore. Thus, should the last impact of a concentric projectile, when fired from a gun, be on the right-hand side of the bore, as represented in Fig. 1, it will have a tendency to deflect to the left in the direction *b*, while at the same time a rotation will be given to it in the direction indicated by the arrows, or to the right; the effect of this rotation being to cause the projectile itself to deviate to the right during its flight, so that the deflection will not be to the left, but to the right, unless the range is very short. If the projectile leave the gun, rotating on a vertical axis, with its forward part moving from left to right —supposing the observer to be behind the piece— there will be a diminished pressure on the right side, and an increased one on the left side, which will therefore cause it to deviate to the right. If a projectile strike the bottom of the bore, the rotation of the fore-part would be from up downwards, and instead of deflecting to the right, the range would be decreased. Suppose the projectile to rotate in an opposite direction, the results would be reversed. Should it, on leaving, strike any intermediate part of the bore, a compound effect would be produced, according to the position of the point of impact. It appears from these explanations that a projectile leaving the gun, rotating on any axis except one parallel to that of the bore, will deviate according to the direction of the rotation.

Should the center of gravity of a projectile not coincide with the center of figure, it is termed *eccentric*, and is found to deviate according to the position of the center of gravity when the ball is placed in the bore of the gun; should the line joining the center of gravity and the center of figure of a projectile be not parallel to the axis of the bore, the charge of powder will act on a larger surface on one side of the center of gravity than on the other, so that there will be a rotation from the lighter towards the heavier side.

It is found in practice that projectiles deviate in a curved line, either to the right or to the left, the curve rapidly increasing towards the end of the range. This probably occurs from the velocity of rotation decreasing but slightly compared to the velocity of translation; or if a very strong wind is blowing steadily across the range during the whole time of its flight, this deflecting cause being constant, while the velocity of the projectile diminishes, the curve will manifestly increase with the range; the trajectory is, therefore, a *curve of double curvature*, its projection on either a horizontal or vertical plane being a curved line.

From the foregoing considerations it follows that the smoother the surface of the projectiles and the less their windage and eccentricity, other things being equal, the greater will be their accuracy. Experiments show that the preponderating side should be put next the charge, and the line joining the center of gravity and the center of figure should be parallel to the axis of the bore. The position of the preponderating side is found by floating the projectile in a bath of mercury, and the degree of promptness with which an eccentric shot, floated as above, assumes the position due to its preponderance is regarded as the measure of that preponderance.

Elongated Projectiles.—If the projectile come out of the gun perfectly centered, that is, rotating round its longest axis, and having that axis coincident with the line of flight, there will be no tendency, either of the axis of rotation or of the projectile itself, to deflect, so long as the motion is in a straight line, because the resistance of the air will act uniformly all around. As soon, however, as the trajectory has begun to curve downwards under the influence of gravity, the resistance of the air acts more on the under side than on the upper, and effects will be produced depending on the resultant direction of the resistance of the air in relation to the center of gravity. Practically, the path of the projectile is found to result in a deviation increasing uniformly with the distance from the gun, and depending, as to its direction, on the direction of the deflecting force at the moment of its first application. If the deflecting force act on the projectile in a vertical direction upwards, the horizontal projection of the line of flight will be a line deviating to the right or left of the plane of fire, according as the twist is right- or left-handed. If the deflecting force act in the opposite direction, the projectile will be deflected to the left or right, according as the twist is right or left; and whatever be the direction of the deflecting force, the deviation will be a uniformly increasing one at right angles to it.

These effects may be illustrated experimentally by means of a gyroscope provided with a small elongated projectile instead of the disk used for ordinary experiments. The projectile must be made with the greatest care, so that its center of gravity coincides exactly with that of the two rings within which it is placed; the rings are so arranged that one can turn round a vertical axis, and the other round a horizontal axis, the projectile being therefore free to turn in any direction. A cylindrical portion of metal extends beyond the base of the projectile, in prolongation of its longer axis, round which the string is wound to give the required rotatory motion. As the projectile in the gyroscope has no motion of translation, a strong current of air must be directed upon it, so as to represent the resistance of the atmosphere to a projectile moving with a high velocity. The diameter of the nozzle of the blower should be equal to, or rather larger than, that of the projectile, and the center of the blast should be directed below the point of the projectile.

The line of flight is not absolutely a straight line, but becomes a curve of double curvature; and if projected on a vertical plane at right angles to the plane of fire, would consist of a series of cycloidal curves, were the time of flight sufficiently great, increasing the distance of the projectile from the plane of fire by the length of one of them at each revolution. The length of these curves depends upon the amount of the deflecting force, and their number is equal to the number of revolutions made by the projectile in its flight.

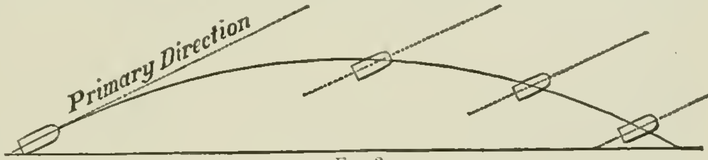


FIG. 2.

When an elongated projectile is fired from a rifled gun, it leaves the bore rotating rapidly round its longer axis; and if the initial velocity were very low, the projectile experiencing but slight resistance from the atmosphere, the larger axis would remain (as in vacuo) during the whole time of flight parallel or nearly so to its primary direction, as shown in Fig. 2. While explaining the effect produced by the resistance of the air upon an elongated projectile moving with a high velocity, the projectile will be supposed to have what is termed a right-handed rotation; that is, the upper part turns from left to right, with reference to an observer placed behind the gun: for the direction of the grooves of rifled pieces is almost invariably so as to give such rotation. After the projectile has left the bore, the resultant of the resistance of the air will, unless the center of gravity be very far forward, act upon a point in front of the center of gravity and below the longer axis, at all angles of elevation given in practical gunnery. The effect produced by this pressure will depend chiefly upon the form of the head of the projectile; therefore let us in the first place consider the effect upon a conoidal head.

Of course the longer axis of an elongated projectile does not remain, during flight, continually a tangent to the trajectory, unless the center of gravity, as in an arrow or rocket, is very near the face-end; yet, practically, on account of the drooping of the point, the longer axis may throughout a considerable portion of the time of flight approximate very nearly to a tangent to the trajectory. The effects on targets furnish most satisfactory evidence of this; it is almost invariably found that the holes made in targets are circular, even when elongated projectiles descend at considerable angles. The most probable explanation of this fact must evidently be that the point of the projectile has drooped during flight, so that, on striking, the longer axis is nearly perpendicular to the plane of the target.

This drooping of the point is of importance; for did the axis remain parallel during flight to its primary direction, the projectile would most probably, when fired at any but a very low angle, on striking an object of hard material and solid structure, turn up against it lengthways, and therefore produce but trifling effect. This has not, however, been found to take place in practice; but on the contrary the penetration of elongated projectiles at considerable ranges is always remarkably great. There is little fear of the projectile turning up against an object unless the velocity of translation and rotation be very low, and the angle of fire very high.

It is found in practice that conoidal-headed projectiles fired from rifled guns giving a right-handed rotation always deviate to the right; and in the few cases tried with guns giving a left-handed rotation the deviation is to the left; with flat-headed projectiles these deviations are reversed. This peculiar deviation is called *drift*, and is generally constant for the same ranges; so that it can be allowed for in pointing the gun, by using a horizontal slide graduated and attached to the tangent scale, or by inclining the tangent scale to the left. See *Projectiles* and *Trajectory*.

DEVICE.—A motto expressed by means of a pictorial emblem. The motto proper originated in the emblem, a written inscription coming to be added to the pictorial design, with the view of rendering the meaning more explicit. Devices thus consist of two parts—a pictorial figure called the "body," and a motto in words called the "soul" of the device. As early as the times of Æschylus, the "Seven Heroes before Thebes" all appear with devices on their shields; and the same is related by Xenophon of the Lacedæmonians and Sicyonians. In the Middle Ages, devices on coat-armor came into regular and formal use, and Chivalry employed them in its courtly expressions of devotion to the fair sex. They were used both as charges on the shield and as crests. The only respect in which the device differs from other heraldic emblems is that it has always some specific reference to the history, or circumstances, or position of the bearer. As an example: Louis XIII. of France had a falcon as a device, with these words: "*Aquila generosior ales*" (A more generous bird than the eagle), by which he meant to denote his own superiority to the Emperor, whose device was an eagle. Devices, moreover, were generally borne only by the individual who assumed them, and not by the other members of his family or his descendants, like the crest or cognizance. They were often contrived to typify a special enterprise, the general character of the wearer, or even to designate his name—as the *mulberry* trees in the embroidered trappings of the horse of Thomas Mowbray, Duke of Norfolk. On all festal occasions they figured on triumphal arches, on banners and hangings. At a later period it became customary to work devices into buildings: friezes and stained windows were often covered with them. This practice has recently much gone out, at least in its original form. See *Heraldry*.

DEXTER RIFLE.—A breech-loading small-arm possessing a fixed chamber closed by a movable breech-block, which rotates about a horizontal axis at 90°. to the axis of the barrel, lying below the axis of the barrel and in front—being moved from above by a thumb-piece.

The arm is opened by half- or full-cocking the hammer, and then swinging down the breech-block by depressing the thumb-piece on the right side of the frame. This pushes back the firing-pin and the locking-brace, by the cam acting on the firing-pin retractor and locking-brace retractor respectively. It is closed by raising the thumb-piece, so as to swing the breech-block up into place. In so doing, the locking-brace is thrown forward by its spring into place under the breech-block, as soon as the latter is closed.

The piece is locked by the position of the locking-brace, the lower end of which abuts upon the guard, and is fired by a center lock of the usual pattern. Both extraction and ejection are accomplished by a revolving extractor, pivoted near the breech-block pin, and struck by the block in its descent. In opening the block the locking-brace is forced against the trigger, and is held there by the block; the hammer, therefore, cannot be made to fall while the piece is opened.

DHALL-BUSH.—The wood used in India in the preparation of charcoal for gunpowder. It grows in most parts of India, and has been found to make the best charcoal of the several woods at present known in that country. Dhall-bush has a growth of a few months: the seed is planted in April, and the grain ripens about the 1st of January the next year, when the bushes are cut down. The stalks are brought in and stacked for use at the powder-works. The wood is white and soft, and contains much saccharine matter. Hence insects breed internally, while externally it is attacked by various moths, which deposit their larvæ. The charcoal is good, its fibrous texture distinct, and it rings with a clear, metallic sound, being at the same time soft and friable. A *beegah of urhur*, another word for the dhall-bush, is calculated to give about 200 maunds of wood in its yearly crop, or the charcoal for 160 barrels; hence 10,000 barrels would require a yearly cultivation of 60 beegahs. As a general rule, the wood should be stripped of its bark previous to charring; this practice was not uniformly pursued in the Indian powder-manufactories in former years, owing, it is supposed, to the expense, and, perhaps, the importance of peeling the wood not having been realized. The peeling process is now strictly carried out. See *Charcoal*.

DHAO.—A Burman tool or weapon (half chopper, half sword) used in clearing jungle and in cutting down trees of all kinds. The Burmese make great use of this cutting instrument.

D'HARSCH SYSTEM OF FORTIFICATION.—In this system the enceinte en tenaille consists of a mere wall, forming a parapet, and covered by counterguards, ravelins, and lunettes. Defensive barracks are constructed on the terre-plein of the ravelins.

DHURREE.—An Indian term for a coarse kind of cotton carpet, called also a *satringee;* it is used for the flooring of tents, and very generally for carpets in most houses in the Northwest Provinces of India. This kind of cloth is made in different parts of the country, and very often by prisoners in jails. A small satringee is issued by the Commissariat Department to every European soldier, which is placed on his sleeping-cot in barracks, and in which his bedding is folded up on the march.

DIABLE.—A truck-carriage on four trucks, used for moving heavy ordnance short distances; it is provided with draught-hooks at each end, so as to be easily drawn to front or rear.

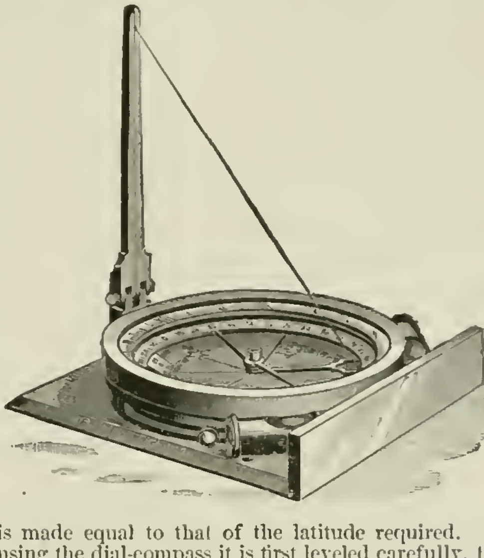
DIADEM.—The name given to the fillet of silk, woolen, or linen which served as the distinguishing ornament of kings. It was generally narrow, being only a little broader on the forehead. The diadem of the Egyptian goddesses and kings bore the symbol of the sacred serpent. The diadem of Bacchus, as it appears in ancient sculptures, was a plaited band going round the forehead and temples, and tied behind, with the ends hanging down. Among the Persians the diadem was bound round the tiara or turban, and was of a blue color, worked with white. The early Roman Emperors refrained from using this ornament, in order not to call up recollections of the hated kingly office. Diocletian was the first to introduce it again, and Constantine the Great added new ornaments to it. After his time it was adorned with a single or double row of pearls and precious stones. Queens are also seen on coins ornamented with the diadem, with the addition of a veil. It was finally superseded by the crown. See *Crown.*

DIAGOMETER.—A kind of electroscope, in which a dry pile is employed to measure the amount of electricity transmitted by different bodies or determine their conducting power. Used to detect foreign mixture in olive-oil.

DIAGONAL. — In plane geometry, a straight line joining any two angles, not adjacent, of a rectilineal figure. A line drawn between two adjacent angles would coincide with the boundary-line. A triangle has no diagonal, because any two of its angles are adjacent; a four sided figure has two diagonals; a five-sided, five; a six-sided, nine; etc. The number of possible diagonals in any figure is found by taking three from the number of sides, multiplying the remainder by the number of sides, and taking half the product. Thus, in the six-sided figure, the process is $\frac{3 \times 6}{2} = 9$. If the diagonals must be so drawn as not to intersect, their number is always three less than the number of sides. It makes no difference whether they all proceed from one angle or not. A diagonal in a solid bounded by planes is a line joining any two solid angles so situated that the line does not coincide with any line on the surface. To find the number of such diagonals in a given solid: Multiply the number of solid angles by the same number diminished by one, and from half this product subtract the number of edges on the figure, and also the sum of the number of diagonals in all the faces. Thus, the cube gives $\frac{8 \times 7}{2} - 12 - 6 \times 2 = 4$ diagonals.

DIAGONAL SCALE.—A system of lines by means of which hundredths of units may be laid down or measured with compasses. When the numbers representing the lengths of the sides of any figure would give lines of an inconvenient size taken from the scale, the numbers may be all multiplied or all divided by such a number as will adapt the lengths of the lines to the required dimensions of the figure. See *Scale*.

DIAL-COMPASS. — This little instrument has a needle three inches long, and with its compass-circle is inclosed in a circular box set upon a brass base four inches square, three edges of which are chamfered and divided; one on the W side of the compass into inches and tenths, the two others into degrees and half-degrees, and figured from a center on the southwest corner of the base. The compass-circle is movable in order to set off the variation of the needle, and has a vernier attached to it on the inside, reading a divided arc on the face of the compass to three minutes of a degree. There is also on the south side of the face an arc of 180°, figured from 0 to 90 on each side of the south or zero line of the face. A little pendulum with index-point hung from the center-pin reads this arc, when the compass is set up, vertical, on the raised south edge, thus making it a clinometer or slope-measurer. The sight is hinged so as to fold in packing, but when erect makes taut a fine silk thread attached at one end to the sight and at the other to a brass hour circle above the compass-glass, at an angle with the plane of the hour-circle equal to that of the latitude of the place where the compass is used. The hour-circle is divided for any required latitude like that of a sun-dial, the hair serving as a gnomon to give apparent time with the sun. When it is desired to use the instrument at a latitude a degree or two either higher or lower than that for which the hour-circle is divided, the end of the thread attached to the sight may be made adjustable, so as to be either raised or lowered on the sight until the angle of the thread with the plane of the hour-circle



is made equal to that of the latitude required. In using the dial-compass it is first leveled carefully, the equation of time for the given day allowed for, and then by observation on the sun at midday the true meridian approximately obtained. The needle may then be set to the meridian by laying off the variation, and any deflection of the needle from the true meridian will indicate the presence of veins of magnetic iron-ore. See *Clinometer* and *Solar Compass*.

DIAMAGNETISM.—The fact that iron is attracted by the magnet has been known from very remote times; that bismuth exhibits a repulsive action towards the magnetic needle has been now known for nearly a hundred years. Dr. Faraday was the first (1845) to show that all bodies are more or less affected by magnetic influence, and his beautiful researches on the subject have opened up a new field in the domain of science. He found that the magnetism of bodies was manifested in two ways—either in being attracted by the magnet, as iron, or in being repelled, like bismuth. When a needle or slender rod of iron is suspended between the poles of a magnet, as in Fig. 1, being

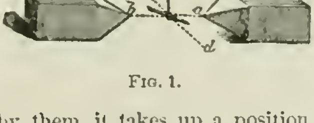


FIG. 1.

attracted by them, it takes up a position of rest on the line, *a b*, joining the two poles. When a substance behaves itself in this manner, it is said by Faraday to be *paramagnetic*, and to place itself *axially*, *a b* being the axis. A rod of bismuth, on the other hand, being repelled by the poles of the magnet, comes to rest in the line, *c d*, at right angles to *a b*. Bismuth, and the like substances, he calls *diamagnetic*, and they are said to place themselves *equatorially*, *c d* being the equator. These terms, being both definite and graphic, have been universally adopted. Magnetic is the term used by Faraday to indicate magnetism of either sort, although in general language it is understood to refer to paramagnetic bodies, such as iron, etc. Paramagnetic bodies, then, are those which manifest the same properties with regard to the magnet that iron does; and diamagnetic bodies are those which, like bismuth, show opposite but corresponding properties; so that in circumstances where paramagnetic bodies place themselves axially, diamagnetic bodies place themselves equatorially; and where the former are attracted, the latter are repelled, and *vice versa*. A paramagnetic, therefore, not in the elongated form, but in a compact shape, such as a ball or cube, is attracted by either pole of the magnet when suspended near it; a ball or cube of a diamagnetic, on the other hand, experiences, when so placed, repulsion. The paramagnetism of iron, nickel, and cobalt becomes manifest in the presence of magnets of ordinary power; but the magnetism of most other substances is so feeble as to be developed only under the influence of the strongest magnets. As electro-magnets far exceed permanent steel magnets in strength, they are selected for investigations on the magnetism of bodies. To observe the effect of the magnet on liquids, Faraday placed them in long tubes of very thin glass, and suspended them as in the case of solid needles. It was found that some arranged themselves axially, and others equatorially. The attraction and repulsion that liquids experience in the presence of the magnet has been prettily shown by Plucker. A large drop of liquid is placed in a watch-glass, Figs. 2 and 3, and laid upon two poles of the magnet. If the liquid be paramagnetic, the surface becomes depressed at the interval between the poles, and heaped up over the extreme edges of them, Fig. 2. A diamagnetic liquid, on the other hand, shows a de-

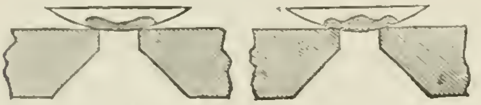


FIG. 2. FIG. 3.

pression at each edge of the poles, and a heaping up at the center, Fig. 3. The magnetic nature of flames and gases has been also studied. When the flame of a candle is brought between the poles of a magnet, it is repelled by them, and thrown out horizontally into an equatorial position. To ascertain the magnetism of gases, Faraday inflated soap-bubbles with them, and their para- or dia-magnetism was exhibited by their being attracted or repelled by the poles. He ascertained the same by causing the gases to flow out from glass tubes in the presence of the poles, when the peculiar magnetism of the gas was shown by its choosing an axial or equatorial means of egress. The following list gives the kind of magnetism displayed by the more common substances: *Paramagnetic*—Iron, nickel, cobalt, manganese, chromium, titanium, palladium, paper, sealing-wax, peroxide of lead, plumbago, red-lead, sulphate of zinc, shellac, vermilion, charcoal, proto and per salts of iron, salts of manganese, oxygen, air. *Diamagnetic*—Bismuth, antimony, zinc, tin, cadmium, sodium, mercury, lead, silver, copper, gold, arsenic, uranium, tungsten, rock-crystal, mineral acids, alum, glass, litharge, niter, phosphorus, sulphur, resin, water, alcohol, ether, sugar, starch, wood, bread, leather, caoutchouc, hydrogen, carbonic acid, coal-gas, nitrogen. The nature of the medium in which the body under examination moves exerts a powerful influence on the nature and amount of the magnetism it exhibits; thus, if a glass tube be filled with a solution of the protosulphate of iron, and suspended between the poles, it will place itself axially. It will do the same if made to move in water, or a solution more dilute of the protosulphate of iron. It will be indifferent in a solution of the same strength; but it will place itself equatorially in a stronger solution. Thus, the same substance may appear paramagnetic, indifferent, or diamagnetic according to the nature of the medium in which it moves. As a general rule, a body shows itself paramagnetic towards one less paramagnetic than itself, indifferent towards one equally magnetic, and diamagnetic towards one more paramagnetic than itself. The same takes place, *mutatis mutandis*, with diamagnetic substances This has given rise to the theory that there is no such thing as diamagnetism *per se*, and that bodies are diamagnetic only in media of greater paramagnetic power than their own. This view of the case is, however, rendered highly improbable from the fact that diamagnetism is exhibited as decidedly in a vacuum as in any medium, and a vacuum cannot be supposed to possess magnetic properties of any kind.

DIAMETER.—A line passing through the center of a circle, bounded at each end by the circumference. When great accuracy is not required, the proportion of the diameter of a circle to the circumference may be taken as 1 to 3.1416. To find the diameter of a spherical shot, its weight being given, multiply the cube root of the shot's weight by 1.923 for the diameter. In taking the diameter or caliber of the bore of a rifled gun, it is measured across the *lands*.

DIAMOND-POINT.—A stylus armed with a diamond, either ground, conical, or made of a selected fragment of the desired shape. Wilson Lowry introduced the diamond-point into engravers' ruling-machines. Etching-tools have been pointed with diamonds. Diamond-points are used in ruling the graduation of the finer kinds of instruments; also by Nobert, it is supposed, in ruling the wonderful series of lines that form the tests of the microscopes of higher powers.

DIAMOND-TOOL.—A metal-turning tool whose cutting edge is formed by facets. Much used in the arsenal.

DIAPHRAGM-SHELL.—A shrapnel shell used in the English service. It is used with smooth-bore ordnance, and is an improvement on the original shrapnel shell; it is the invention of General Boxer, R.A. It has a wrought-iron partition or diaphragm which separates the bursting-charge from the bullets. The channel of communication, termed the loading-hole, from the exterior of the shell to the powder-chamber, into which the bursting-charge is poured, is closed and opened by a small screw. The bursting-charge in this shell is considerably reduced, and the interior of the shell is coated with marine glue, in order to insure complete separation between the powder of the bursting-charge and the coal-dust thrown between the bullets. The bursting of the shell is facilitated by four grooves formed in its interior surface which act as so many lines of "least resistance." See *Shell*.

DIAPRE.—A term applied in Heraldry to fields and charges relieved by arabesque and geometrical patterns. These patterns were generally of a darker shade of the same tincture. This being merely an ornamental device, not affecting the heraldic value of the objects to which it was applied, was generally left to the fancy of the painter. See *Heraldry*.

DICTATOR.—In the earliest times, the name of the highest Magistrate of the Latin Confederation, and in some of the Latin towns the title was continued long after these towns were subjected to the dominion of Rome. In the Roman Republic the Dictator was an extraordinary Magistrate, irresponsible and endowed with absolute authority, whose original name was *Magister Populi*. The frequency of *crises*, or critical periods, in the quick, aggressive growth of the Roman State necessitated such an office. The first Dictator (T. Larcius or M. Valerius) was appointed 501 B.C., nine years after the expulsion of the Tarquins. According to Livy, the immediate cause of this dictatorship was a formidable war with the Latins. In general no one could be appointed Dictator who had not been previously Consul, and this condition was very rarely dispensed with. Niebuhr is of opinion that the Dictator was originally created or elected by the Curiæ, like the Kings, but it is more probable that the Senate passed a decree ordering one of the Consuls to name or proclaim (*dicere*) a Dictator. Originally, of course, the Dictator was a Patrician; the first Plebeian who filled the office being C. Marcius Rutilus, 356 B.C., who was nominated by the Plebeian Consul M. Popillius Lænas. The Dictatorship could not *lawfully* be held longer than six months, nor was it ever so, except in the cases of Sulla and Cæsar, which were altogether peculiar. It must not be supposed that during a Dictatorship the functions of the other Magistrates were positively suspended. The Consuls and other regular authorities continued to discharge their proper duties, but in subordination to the direction and command of the Dictator; being for the time simply his officers. The superiority of his power, when compared with that of the Consuls, appears chiefly in these three points: he was far more independent of the Senate; he had a more extensive power of punishment, without any appeal; and he could not be called to account after his abdication of the Dictatorship for anything he had done during the period of his office. The *limits* of his power were as follows: he could not touch the Treasury; he could not leave Italy; and he could not ride through Rome on horseback without previously obtaining the permission of the people. While the Consuls had only 12 Lictors, the Dictator was preceded by 24, bearing the *secures* and *fasces*. To him also belonged the *sella curulis* and the *toga prætexta*. The last legally elected Dictator was M. Junius Pera, who entered on his office 216 B.C. From this time *nominal* Dictators were frequently appointed for the purpose of holding the elections, but even these finally disappeared, 202 B.C. Henceforth, in critical times, a sort of dictatorial power was conferred on the Consuls by the Senate by the well-known formula, "That the Consuls should see to it that the State should receive no damage." This practice rendered the appointment of *Dictators* no longer necessary.

DIDION'S FORMULAS. — In consequence of the variable nature of the resistance of the air, it has been found impossible to integrate the differential equations of the real trajectory, even under the supposition that this resistance varies in as simple a ratio as the square of the velocity. Several distinguished mathematicians have obtained expressions which approximate to the true results, but the expressions are generally too complicated to be of much practical value.

Captain Didion, Professor of Gunnery in the Artillery School at Metz, however, furnishes an approximate solution to this difficult question, which may be used in practice. To do this, he considers the resistance of the air equal to

$$A\pi R^2\left(1+\frac{v}{r}\right)v^2;$$

and by assuming a mean value for the different inclinations of the elements of the trajectory to their horizontal projections, which makes $\frac{ds}{dx}$ constant, he is able to integrate the differential equations, and place them under the following forms:

$$y = x\tan A - \frac{g}{2}\,\frac{x^2}{V^2\cos^2 A}\,B;$$

$$\tan\theta = \tan A - g\frac{x}{V^2\cos^2 A}I;$$

$$t = \frac{x}{V\cos A}D; \qquad v = \frac{V\cos A}{\cos\theta}\,\frac{1}{U}.$$

The same notation being preserved as in the equations in the article Equations of Motion of Projectiles, it will be perceived that the equations in air differ from those in vacuo by the multipliers B, I, D, and U respectively. The multiplier B relates to the fall of the projectile; I, to the inclination; D, to the duration; and U, to the velocity; they are each functions of $\frac{\alpha x}{c}$ and $\frac{\alpha V}{r}$; in which α is the constant relation of the arc to its projection, $V_1 = V\cos A$, and c and r are coefficients of the formula for the resistance of the air. The general expression for a particular multiplier, B for instance, is $B\left(\frac{\alpha x}{c};\frac{\alpha V}{r}\right)$. The values B, I, D, and U, for such values of c and r as are likely to arise in service, have been computed, and arranged in tabular form.

So long as the inclination of the trajectory is slight, α differs but slightly from unity; for an angle of 15° it does not exceed .01; and as it only enters into the term which relates to the resistance of the air, the error does not exceed a pressure corresponding to .25 inch in the height of the barometer; it may, therefore, be regarded as unity, and $\frac{\alpha x}{c}$ reduces to $\frac{x}{c}$. The same with regard to $\frac{\alpha V}{r}$, or $\frac{\alpha V\cos A}{r}$; as $\alpha \cos A$, when $A = 10°$, differs only about .01 from unity; and this expression may be reduced to $\frac{V}{r}$. When the angle of projection does not exceed 3°, cos A differs only .001 from unity, and we can everywhere replace $V\cos A$ by V. Under this angle, $\frac{\cos A}{\cos\theta}$ differs but slightly from unity, and we have $v = \frac{V}{U}$, which is the same as if motion took place in a horizontal plane.

All cases of the movement of projectiles which occur in practice may be divided into three distinct classes: 1st. When the angle of projection is slight or does not exceed 3°, as in the ordinary fire of guns, howitzers, and small-arms; 2d. When the angle of projection is greater than this, but does not exceed 10° or 15°, as in ricochet-fire, etc.; 3d. When the angle of projection exceeds 15°, as in the fire of mortars.

1st Class. *For small angles of projection, as in guns, howitzers, and small-arms.* — For slight variations of the angle of projection above or below the horizon, the form of the trajectory may be considered constant; and when the object is but slightly raised above or depressed below the horizontal plane, it may be considered as in this plane. In consequence of the windage, and the balloting of the projectile which results from it, the projectile does not always leave the bore in the direction of the axis. The angle formed by the line of departure and the axis of the piece is called the *angle of departure*. For guns in good condition the vertical deviations do not exceed 5′, and for howitzers 10′; the side deviations never exceed 4′ 30″. To obtain exact results, therefore, it is necessary to correct the angle of projection for the angle of departure, when the latter is known. Under the supposition that α, cos A, and $\frac{\cos A}{\cos\theta}$ are each equal to unity, the equations of the trajectory in air may be reduced to

$$y = x\tan A - \frac{gx^2}{2V^2}B; \quad . \quad . \quad . \quad (1)$$

$$\tan\theta = \tan A - g\frac{x}{V^2}I; \quad . \quad . \quad . \quad . \quad (2)$$

$$t = \frac{x}{V}D; \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (3)$$

$$v = \frac{V}{U}. \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (4)$$

Knowing the weight and diameter of the projectile, c can be calculated by the formula $c = \frac{2\,RD}{3\,gA}$ if it be not found in the table which accompanies it. We know $\frac{x}{c}$ and $\frac{V}{r}$, and by means of the tables can determine the desired values of B, I, D, and U.

Of the three things, the initial velocity, V, the distance of the object, X, and the angle of projection, A, two being known, to determine the third.

1. *To determine the angle of projection, A.*—Make $y = 0$ in equation (1), and solve it with reference to $\tan A$; we have

$$\tan A = \frac{g}{2}\frac{X}{V^2}B.$$

2. *To determine the initial velocity, V.*—Make $y = 0$ in equation (1), solve it with reference to V, and multiply both members by $\frac{1}{r}$; we have

$$\frac{\frac{V}{r}}{\sqrt{B}} = \frac{1}{r}\sqrt{\frac{g}{2}\frac{X}{\tan A}} = q.$$

Having the values of $\frac{X}{c}$ and q, seek in the Tables of Multipliers for the value of $\frac{X}{c}$ the value of $\frac{V}{r}$, which gives that of q; multiply $\frac{V}{r}$ by 1427 and we shall have V.

3. *To determine the range, X.*—Make $y = 0$ in equation (1), obtain the value of X, and divide both members of the equation by c; we have

$$\frac{X}{c}B = \frac{\tan A V^2}{c\frac{1}{2}g} = p.$$

Having the initial velocity, V, and angle of projection, A, we can determine $\frac{V}{r}$ and p; seek in the tables for the value of $\frac{V}{r}$ that of $\frac{X}{c}$, which gives p; having $\frac{X}{c}$, multiply it by c, and we have X.

In firing spherical case-shot it is important not only to know the time of flight, in order to regulate the fuse, but it is important to know that the projectile will have sufficient remaining velocity to render the impact of the contained projectiles effective.

4. The *time of flight* can be obtained from equation (3), or $t = \frac{x}{V}D$. Knowing $\frac{x}{c}$ and $\frac{V}{r}$, we can obtain the corresponding value of D from the tables.

5. The *remaining velocity* can be obtained from equation (4), or $v = \frac{V}{U}$. Knowing $\frac{X}{c}$ and $\frac{V}{r}$, obtain from the tables the corresponding value of U.

2D CLASS. *For angles of projection not exceeding* 10° *or* 15°, *as in the ricochet-fire of guns, howitzers, and mortars.*—The formulas are:

$$y = x\tan A - \frac{g}{2}\frac{x^2}{V^2\cos^2 A}B; \quad . \quad (5)$$

$$\tan\theta = \tan A - g\frac{x}{V^2\cos^2 A}I; \quad . \quad . \quad . \quad (6)$$

$$t = \frac{x}{V\cos A}D; \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (7)$$

$$v = \frac{V\cos A}{U\cos\theta}. \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (8)$$

If the object be on a level with the piece, the solution of this class of problems is the same as those of class 1st, when the angle is very small; if not, it will be necessary to substitute for V, $V = V\cos A$, and after having obtained V, divide it by $\cos A$, which gives V. The object being situated at the distance a from the piece, and at the distance b above the horizontal plane passing through the center of the muzzle, is seen under an *angle of elevation* ε, for which $\tan\varepsilon = \frac{b}{a}$. One of the two things, the initial velocity or angle of projection, being known, to determine the other.

1. *To determine the initial velocity, V.*—Substitute in equation (5) the co-ordinates a and b, and V_i; solve it with reference to V; substitute $\tan\varepsilon$ for $\frac{b}{a}$, and divide both members by r. We have

$$\frac{\frac{V_i}{r}}{\sqrt{B}} = \frac{1}{r}\sqrt{\frac{\frac{g}{2}a}{\tan A - \tan\varepsilon}} = q.$$

Having the value of q, seek in the tables for the known value of $\frac{a}{c}$ the value of $\frac{V_i}{r}$ corresponding to it, and multiplying by $\frac{r}{\cos a}$, we shall have V.

2. *To determine the angle of projection.*—The result will be sufficiently near the truth if we substitute, in equation (5), V for V_i, or $V\cos A$; and solving it with reference to $\tan A$, we have

$$\tan A = \tan\varepsilon + \frac{ga}{2V^2}B,$$

in which we substitute for B its value corresponding to $\frac{a}{c}$ and $\frac{V}{r}$, obtained from the tables.

3D CLASS. *Properties of trajectories under high angles of projection.*—As a projectile rises in the ascending branch of its trajectory, its *velocity* is diminished by the retarding effect of the air and the force of gravity: in consequence of the resistance of the air alone, the velocity continues to diminish to a point a little beyond the summit of the trajectory, where it is a minimum; and from this point it increases, as it descends, under the influence of the force of gravity, until it becomes uniform, which event depends on the diameter and weight of the projectile and the density of the air, or, in other words, upon the value of c. The *inclination* of the trajectory decreases from the origin to the summit, where it is nothing; it increases in the descending branch from the summit to its termination, and if the ground did not interpose an obstacle, it would become vertical at an infinite distance. An element of the trajectory in the descending branch has a greater inclination than the corresponding element of the ascending branch. Strictly speaking, the trajectory in air is an exponential curve with two asymptotes; the *first* is the axis of the piece, which is tangent to the trajectory when the initial velocity is infinite; the *second* is the vertical line toward which the trajectory approaches as the horizontal component of the velocity diminishes and the effect of the force of gravity increases. The *curvature* of the trajectory increases in the ascending branch to a point a little beyond the summit. The point of greatest curvature is situated nearer the summit than the point of minimum velocity. In the fire of mortar-shells under great angles of projection, and at customary distances, the trajectory may be considered as an arc, in which the angle of fall is slightly greater than the angle of projection. In the ascending branch the arc commences under an angle of A, and terminates under an angle of 0; the ratio of the length of this arc to its projection, or α, is calculated for all arcs from 5° to 75°, and arranged in groups of fives. The value of α is considered the same in the descending as in the ascending branch. The multipliers, B, I, D, and the divisor, U, are calculated for the values $\frac{\alpha x}{c}$ and $\frac{\alpha V}{r}$, and they are employed in equations (5), (6), (7), (8), as in the preceding class of cases.

1. *Find the initial velocity of a mortar-shell, knowing the range and angle of projection.*—We know $\frac{\alpha x}{c}$, and by solving equation (5) as before we have

$$\frac{\frac{\alpha V}{r}}{\sqrt{B}} = \frac{\alpha}{r}\sqrt{\frac{\frac{1}{2}gX}{\tan A}} = q.$$

Having determined the value of q, seek in the tables the value of $\frac{\alpha V}{r}$ corresponding to it for $\frac{\alpha x}{c}$; then multiply it by $\frac{r}{\alpha \cos A}$, and we have V.

2. *To determine the angle and velocity of fall, and the time of flight, knowing the initial velocity and range.*

3. *To determine the range, knowing the initial velocity and angle of projection.*—We have α and $\frac{\alpha V}{r}$; make $y = 0$ in equation (5); solve it with reference to X, and multiply both members by $\frac{\alpha X}{c}$, and we have

$$\frac{\alpha X}{c} B = \frac{\alpha V^2}{gc} \sin 2A = p.$$

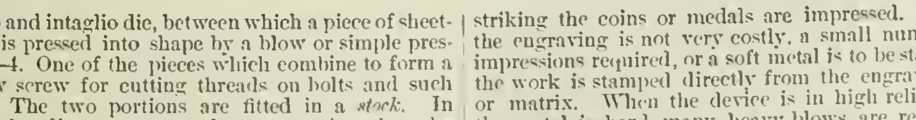
Having found the value of $\frac{\alpha X}{c}$, which for $\frac{\alpha V}{r}$ gives p, multiply it by $\frac{c}{\alpha}$, and we have X.

In consequence of considering the inclination of the trajectory as constant in the preceding equations, the resistance of the air is slightly underestimated in the more inclined portions of the trajectory, or at the beginning and end, and slightly overestimated in the less inclined portions, or about the summit. It follows that the calculated trajectory will at first rise above the true one, then pass below it, and again pass above it; the calculated ranges will therefore be found slightly in excess. From the law of inertia, a rifle-projectile moves through the air with its axis of rotation parallel to the axis of the bore. Hence it follows that an oblong projectile, fired under a low angle of projection, presents a greater surface toward the earth, and less parallel to it, than a round projectile of the same weight; consequently the vertical component of the resistance of the air is greater, and the horizontal component less, in the first case than in the second. The effect of this will be to give an oblong projectile a flatter trajectory and longer range than a round one. See *Equations of Motion of Projectiles, Multipliers, Projectiles,* and *Resistance of the Air.*

DIE.—1. In punching-machines, a bed-piece which has an opening the size of the punch, and through which the piece is driven. This piece may be a planchet or blank, or it may be merely a plug driven out of the object to form a bolt- or rivet-hole. In nut-machines the nut-blanks may be made by one die and punched by another.—2. A device consisting of two parts which coact to give to the piece swaged between them the desired form.—3. A former and punch, or a cameo and intaglio die, between which a piece of sheet-metal is pressed into shape by a blow or simple pressure.—4. One of the pieces which combine to form a hollow screw for cutting threads on bolts and such like. The two portions are fitted in a *stock.* In some the dies are set up by screws, in others by scrolls. The drawing represents the Billings stock and dies. The arrangement for holding in the dies is novel. Two feathers hold the dies in position, as shown in the drawing. Turning the screw from the top die and pressing on the pin at the lower edge of the plate leaves the dies free to fall out. A pair of dies for holding *taps* may be used in the plate in place of the thread-dies, making a very convenient tap-wrench and at the same time saving the necessity of an extra wrench, as it combines the two.

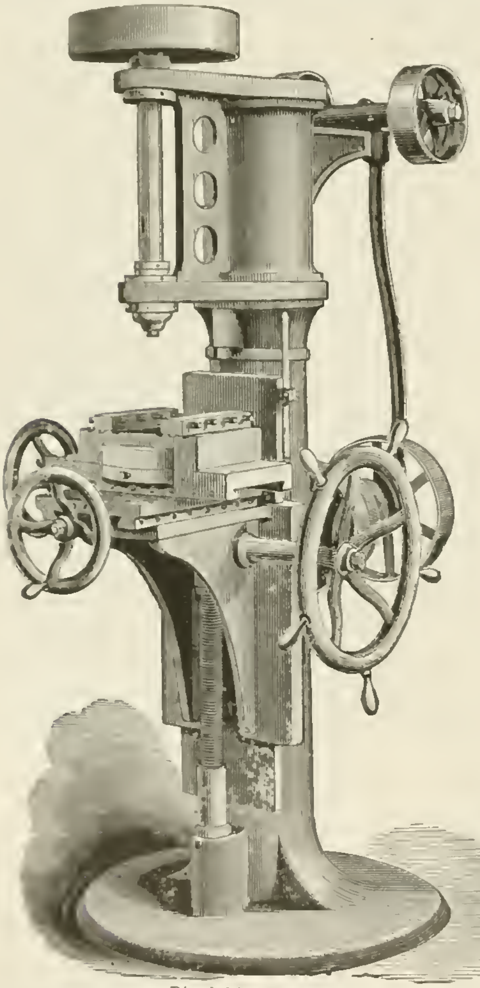
DIEGO.—A very strong and heavy sword commonly used in combat.

DIE-SINKING.—The art of engraving the die or stamp used for striking the impression on coins, etc., and for stamping thin plates of metal into various devices. The importance of die-sinking has much increased of late on account of the great extension of the process of stamping thin metal. Many kinds of work formerly bent into shape by the hammer and punch are now struck by a few blows between suitable dies. As examples of these we may mention the ornamental work of gas-fittings, window-curtain cornices, common jewelry, ornamental trays, dishes, boxes, etc. For such purposes a pair of dies is required, one in relief, the other in intaglio, and the metal is pressed between them. Not only are ornamental articles stamped in this manner, but useful articles, composed of many parts, are made entirely by cutters and dies, each part being cut and stamped by a pair of dies, and then the parts united by another pair, the junction being effected by overlaps, which the uniting dies press into their places. The astonishing cheapness of many of the Birmingham products is mainly due to the use of dies for doing by a single blow the work that formerly required long and tedious manipulation. The most ancient and familiar application of dies is in the striking of coins and medals; the method of sinking the dies used for this purpose will serve to illustrate the general method of die-sinking. Suppose the coin to be of the size of a shilling: a cylindrical piece of steel, about three or four inches in length, and two in diameter, is prepared by slightly rounding one end of the cylinder, then turning and smoothing upon the middle of this a flat face equal to the size of the coin. This blank die, which is carefully softened, is then engraved with the device of the coin in intaglio. This is a very delicate and artistic process, and is effected by a great number of careful touches with small and very hard steel tools. The face of the die is now hardened by placing it face downwards in a crucible upon a layer of bone-dust, or a mixture of charcoal and oil. In this position it is raised to a cherry-red heat, then taken out and plunged in water. When properly tempered, it is in a state to be used for stamping the coin; but dies of superior workmanship, from which many impressions are required, are not thus directly used, as the expense of engraving is very great, and the risk of breakage considerable. This first engraved die, called the matrix, is therefore reserved only for making other dies. An impression in relief is made from this matrix on a small block of steel, which is called the puncheon; this is retouched and hardened, and from it the dies directly used for striking the coins or medals are impressed. When the engraving is not very costly, a small number of impressions required, or a soft metal is to be stamped, the work is stamped directly from the engraved die or matrix. When the device is in high relief, and the metal is hard, many heavy blows are required. Some of the finest large bronze medals require 200 or 300 blows for each impression, and the metal has to be annealed by heating between every two or three blows. It is on this account that the difference between the price of pewter and bronze medals of the same subject is so great, the pewter being so much softer. Copper, although harder than pewter, is much softer than bronze, and hence the reader will easily understand



Billings Stock and Dies.

why the device on the bronze coinage, manufactured at the new mint of Birmingham, is in much lower relief than the old copper coinage, as it would not pay to use repeated blows and annealing in striking common coins. An impression in high relief or in deep intaglio may be obtained by one single blow by the *cliché* method. For this a fusible alloy is used, such as type-metal, or, still better, an alloy of two parts bismuth, one lead, and one tin, which fuses at about 212°, and becomes pasty before solidifying. The metal is poured into a box or tray a little larger than the die, and when in a pasty condition the die is placed over it and struck smartly with a heavy mallet or a coining-press. A steel die is by no means necessary for this; sharp impressions may be obtained from bronze medals themselves, or even from wood and plaster casts. A cliché mold may be made in the first instance from the medal, and then a cliché relief from



Die-sinking Machine.

this mold, if the process is skillfully conducted. The skill required consists mainly in striking the blow with a force proportionate to the depth of the impression and the softness of the metal, and in selecting the right moment for doing so, just as the fused metal is on the point of solidifying; for, if too fluid, it will merely be driven aside; and if at all set, an imperfect impression results. The metal should be of about the consistence of melted sealing-wax, and then the surface is set by contact with the cool die or medal, while the body of the metal still yields to the pressure. Cliché molds are admirably adapted for electro-depositing. The drawing represents the Pratt and Whitney die-sinking machine, which is much used in the arsenal for work on small-arms, recessing dies, and finishing recesses of all varieties of curved or irregular shapes. The work to be operated upon is held in the vise, which may be moved in all directions horizontally by compound slides on the table of the machine, and may be elevated or depressed by the vertical movement of the platen. The cutter, which may be of any suitable size or form, revolves with the spindle which is driven by a belt, giving much smoother action than is possible with gears. The work may be guided either by a pattern or forming-piece, or controlled wholly by the operator. These machines are very strongly built, insuring smooth work, free from chatter-marks, and are adapted particularly to forming and finishing recesses of circular or irregular shape, and for recessing dies for the drop-press. See *Stamping*.

DIETARY.—Rule of diet, or an allowance of food. On the opposite page is the diet-table for hospitals in the United States army.

The following are the recipes for full diet for ten men:

1. Coffee.—Coffee, roasted, 5 oz.; sugar, $6\frac{1}{2}$ oz.; milk, $\frac{4}{5}$ pt.

Directions.—Put the coffee in $4\frac{1}{2}$ quarts of boiling water. Stir well until boiling has recommenced. Cover the boiler and continue the boiling two minutes. Take the boiler off the fire, pour into it one pint of cold water, and replace the cover. In ten minutes the coffee may be carefully poured into coffee-pots, and the sugar and milk added.

2. Tea.—Tea, $\frac{4}{5}$ oz.; sugar, 5 oz.; milk, $\frac{1}{2}$ pt.

Directions.—Put the tea, closely tied up in a bag of netting, into five quarts of boiling water. Let it boil one or two minutes. Take it off the fire and let it stand, covered, on the range fifteen minutes to draw. Add the milk and sugar.

3. Hominy.—Hominy, 15 oz.; salt, $\frac{4}{5}$ oz.

Directions.—Wash the hominy thoroughly in warm water. Put the salt into the boiler with one quart of water. When boiling stir in the hominy. Let it boil, very gently, twelve hours, filling up with boiling water as the water in the boiler wastes, but without stirring. Drain off all the water that remains after it is sufficiently cooked. Add any beans that may be left from Wednesday's dinner to Thursday's breakfast.

4. Rice.—Rice, 1 lb.; salt, $\frac{4}{5}$ oz.; water, 1 gill.

Directions.—Put the salt and water into a boiler, and when boiling add the rice, previously well washed. Boil three quarters of an hour, or until the grains are soft. Drain off the water; let it stand a few minutes beside the fire.

5. Succotash.—Beans, $\frac{1}{2}$ lb.; hominy, $\frac{1}{2}$ lb.; gravy, $\frac{1}{2}$ pt.; salt, $\frac{2}{5}$ oz.; pepper, $\frac{1}{20}$ oz.

Directions.—Wash the beans and hominy thoroughly in three waters to cleanse them. Then put them to soak in a sufficient quantity of water to cover them for five hours, after which pour off the water, being careful to drain them quite dry. Then put them in a boiler or vessel previously prepared with $\frac{1}{2}$ pint of boiling water and boil over a slow fire six hours; then add $\frac{1}{2}$ pint of gravy, $\frac{2}{5}$ ounce of salt, $\frac{1}{20}$ ounce of pepper, and simmer over the fire one hour, after which it is ready for use. Frequent stirring is necessary to keep it from scorching.

6. Gravy.—Beef-drippings, $\frac{4}{5}$ pt.; water, $\frac{2}{5}$ pt.; flour, $2\frac{2}{5}$ oz.

Directions.—Heat the beef-drippings. Mix the flour into a smooth paste with $\frac{8}{5}$ pint of cold water. Stir the paste into $\frac{2}{5}$ pint of boiling water and let it boil 8 minutes. Add to it the hot beef-drippings and let the whole heat together for a few minutes. The gravy will require neither pepper nor salt if the beef from which the drippings are taken has been sufficiently seasoned while roasting.

7. Meat-Hash.—Meat, $2\frac{1}{2}$ lbs.; bread, 10 oz.; potatoes, 15 oz.; pepper, $\frac{1}{10}$ oz.; salt, $\frac{4}{5}$ oz.

Directions.—Chop the meat (previously boiled with the bones) fine; boil and mash the potatoes; mix both together with the bread, crumbled fine, and the pepper and salt, moistening with the broth in which the meat and bones were boiled, without adding water. Simmer for half an hour, stirring constantly.

	Sunday.	Monday.	Tuesday.	Wednesday.	Thursday.	Friday.	Saturday.
Breakfast.....	Coffee..........pt. 1 Bread, wheat or corn..........oz. 6 Hominy. ....oz. 1¼	Coffee...........pt. 1 Bread...........oz. 6 Meat-hash...... .oz. 8	Coffee.........pt. 1 Bread, wheat....oz. 6 Rice, or succotash, with gravy...oz. 1.60	Coffee. ....pt. 1 Bread......... ..oz. 6 Meat-hash...... .oz. 8	Coffee..... . ....pt. 1 Bread, wheat or corn.... ....oz. 6 Hominy, with gravy.............oz. 1	Coffee...........pt. 1 Bread, wheat ....oz. 6 Meat-hash........oz. 8	Coffee. ... .pt. 1 Bread ....oz. 6 Rice, or succotash, with gravy.. .oz. 1.60
Dinner............	Roast beef......oz. 12 Bread ....oz. 4 Potatoes........oz. 10 Other vegetables.oz. 4 Rice-pudding, or savory bread..oz.	Beef or mutton stew........ ..oz. 12 Bread..........oz. 4	Beef-soup with vegetables.....pt. 1 Meat............oz. 12 Bread...........oz. 4 Potatoes........oz. 10	Pork, } ....oz. 6 Beans } Baked, or in soup ....gill. .80 Bread.. ....oz. 4 Potatoes ....oz. 6 Cold-slaw, or beets (pickled).... ...oz. 4	Beef, or mutton (roast).........oz. 12 Bread...........oz. 4 Potatoes...... ..oz. 10 Other vegetables ....oz. 4	Fish.............oz. 6 Potatoes ...... .oz. 10 Bread...........oz. 4 Beets, or other vegetables....oz. 4 Pickles..........oz. 1 Savory bread....oz.	Beef or mutton stew...........oz. 12 Bread...........oz. 4
Supper..........	Tea.............pt. 1 Bread...........oz. 6 Dried fruit (stewed).............oz. 1¼	Tea..............pt. 1 Bread............oz. 6 Cheese...........oz. 1	Tea........... ... pt. 1 Bread............oz. 6 Dried fruit (stewed)..............oz. 1¼	Tea..............pt. 1 Bread............oz. 6 Cheese ....oz. 1	Tea.............pt. 1 Bread... ....oz. 6 Dried fruit (stewed)............oz. 1¼	Tea...........pt. 1 Bread. ....oz. 6 Smoked herring .oz. 2 Or cheese........oz. 1	Tea...............pt. 1 Bread............oz. 6 Cold meat........oz. 4

8. Codfish-hash.—Codfish, 4¾ lbs.; potatoes, 8 lbs.; pork-drippings, ⅝ lb.

Directions.—Put the codfish to soak overnight, fleshy side downward; drain off, and renew the water twice, if possible. In the morning put it into a boiler and simmer it until it is tender. Chop it fine. Have the potatoes boiled and mashed; mix them well with the codfish. Put the whole over the fire; stir in the pork-drippings, and let it heat thoroughly.

9. Codfish, Boiled.—Codfish, 4¾ lbs.

Directions.—Soak the codfish overnight, as for codfish-hash; put it into a boiler with water enough to cover it entirely. Let it simmer gently half an hour, or until tender.

Mackerel, Boiled.—Proceed as with codfish, except that it is to be boiled only a quarter of an hour.

10. Potatoes.—Potatoes, 6¼ lbs.; salt, ⅜ oz.

Directions.—Wash the potatoes thoroughly; put them into boiling water, enough to cover them. Let them boil twenty minutes or half an hour, and drain off the water. Let them remain at the fire a few minutes.

11. Beef-soup.—Beef, 7½ lbs.; flour, ⅛ lb.; turnips, 13 oz.; onions, ½ lb.; cabbage, 10 oz.; pepper, $\frac{1}{16}$ oz.; salt, 2½ oz.; water, 6½ qts.; rice, 2½ oz.

Directions.—Cut the meat in pieces of 3 pounds each; crack the bones, so as to expose the marrow, without splintering them in fine pieces. Put all the ingredients, except the rice and pepper, into a boiler with 6½ quarts of cold water and heat till it boils. Boil very gently for two and a half hours. Take out all the meat; cut it from the large bones, and return the bones to the boiler. When boiling recommences, put in the rice and continue to boil briskly one and a quarter hours. Add the pepper. Have the flour mixed into a smooth paste with cold water; stir it in carefully. Let it boil a quarter of an hour, stirring all the time.

12. Beef (or Mutton) Stew.—Beef or mutton, 3½ lbs.; flour, ¼ lb.; rice, 6½ oz.; potatoes, 1 lb.; pepper, $\frac{1}{16}$ oz.; mixed vegetables, 2 oz.; salt, $\frac{1}{16}$ lb.; water, 1 gal. and 1 pt.

Directions.—Cut the meat in pieces of 6 ounces each. Put it into boiling water with the salt. Let it boil one and a half hours. Add the rice, which must first be thoroughly washed. Boil three quarters of an hour. Cut the potatoes and mixed vegetables into small slices and add them to the meat and rice. Let the whole boil half an hour longer. Put in the pepper. Mix the flour into a smooth paste with cold water and stir it in the stew. Let the whole boil ten minutes, stirring constantly.

13. Roast Beef or Mutton.—Roast beef or mutton, 3½ lbs.; pepper, ⅛ oz.; salt, ⅛ lb.; water, ½ gal.

Directions.—Cut the meat from the bones in as large pieces as practicable; roll and tie them. Bake the meat in pans with the salt and water. Put into the oven and bake three hours, or longer if necessary. Add the pepper ten minutes before it is done. The quantity of meat above named is three quarters of that issued for dinner and the next day's breakfast; the other quarter is to be thrown with the bones, which must be cracked, into a boiler, with water enough to cover them, the whole to simmer until the meat can be easily separated from the bones. The meat with the broth is to be set aside for hash.

14. Pork and Beans.—Pork, 4¾ lbs.; beans, 1 qt.; pepper, $\frac{1}{16}$ oz.

Directions.—Soak the beans overnight in plenty of water. Boil the pork and beans separately for two hours. Put about one seventh of the whole quantity of the pork in pans, surrounded and covered with the beans. Add the pepper. Bake one hour over a moderate fire. Bake the remainder of the pork for the same length of time. Any beans left from dinner will be mixed with hominy for Thursday's breakfast.

15. Cabbage.—Cabbage, 2½ lbs.; salt, ⅜ oz.

Directions.—Put the cabbage and salt in boiling water. Boil half an hour. Drain off the water.

16. TURNIPS.—Turnips, 2½ lbs.; salt, ⅜ oz.

Directions.—Wash the turnips thoroughly and pare them. Put them with the salt into boiling water. Let them boil one hour.

17. COLD-SLAW.—Cabbage, 2½ lbs.; vinegar, $\frac{3}{10}$ pt.

Directions.—Slice the cabbage fine. Pour over the vinegar and mix well.

18. PICKLED BEETS.—Beets, 2½ lbs.; vinegar, $\frac{3}{10}$ pt.

Directions.—Boil the beets two hours. Pare and slice them. Pour the vinegar over them.

19. RICE-PUDDING.—Rice, 10 oz.; sugar, 3¼ oz.; flour, 1$\frac{3}{10}$ oz.; salt, ⅜ oz.; cinnamon, ⅛ oz.; water, 3½ qts.

Directions.—Wash the rice carefully. Put it into the water when boiling, with the sugar and salt. Boil gently three quarters of an hour. Add the flour, previously mixed into a smooth paste with cold water, and the cinnamon. Stir it on the fire carefully for five or ten minutes. Put it into pans and bake for two hours.

20. STEWED FRUIT.—Dried fruit, 15 oz.; sugar, 2 oz.; water, 2½ qts.

Directions.—Soak the dried fruit for three hours in three gallons of water. Drain and add the sugar. Boil gently two hours, or until quite soft.

21. SAVORY BREAD.—Bread, 2½ lbs.; onions, $\frac{1}{10}$ lb.; beef-drippings, ⅛ lb.; pepper, $\frac{1}{10}$ oz.; salt, ⅜ oz.

Directions.—Crumble the bread fine. Chop the onions. Mix together with the beef-drippings, salt, and pepper. Bake until nicely brown. See *Food* and *Ration*.

DIEU ET MON DROIT.—The motto of the Royal Arms of England, first assumed by Richard I., to intimate that he did not hold his empire in vassalage of any mortal. It was afterwards assumed by Edward III., and was continued without interruption to the time of William, who used the motto *Je maintiendray*, though the former was still retained upon the great seal. After him Anne used the motto *Semper eadem;* but ever since her time *Dieu et mon droit* has continued to be the Royal motto.

DIFFERENCES.—Differences, in Heraldry, though often, or indeed generally, confounded with marks of cadency, have, in strict usage, a totally different function—the former being employed to distinguish brothers and their descendants after the death of the father, the latter whilst he is still alive. Differences in this limited sense may consist either of a chief added to or a bordure placed round the plain shield borne by the head of the house; or should the shield exhibit any of the ordinaries, as the bend, fess, pale, etc., the difference may be indicated by an alteration on the lines. The proximity of the bearer to the head of the house is indicated by the character of the line by which the differencing chief or bordure or ordinary is marked off from the field, the following being the order usually observed: the first or eldest brother, on the death of his father, inherits the pure arms of the house; the second brother, if the difference is to consist of a bordure, carries it plain; the third, ingrailed; the fourth, invected; the fifth, embattled; etc. Other modes of differencing have been invented by heralds, and are not unknown to practice; such, for example, as changing the tinctures either of the field or of the principal figures, of which Nisbet gives many famous examples—altering the position or number of the figures on the shield, adding different figures from the mother's coat or from lands, and the like. Where the cadet is far removed from the principal family, if the field be of one tincture, it is sometimes divided into two, the charge or charges being counter-charged, so that metal may not lie on metal, or color on color. The confusion between differences and marks of cadency, above referred to, is by no means peculiar to the heraldic usage of England, though there it is more prevalent than in Scotland. In France the cadets of the House of Bourbon have been in the habit of continuing these marks, and at the present day, as in Mackenzie's time, the label or lambel is to be seen on the arms of all the members of the Orleans family. That no distinction between what we call marks of cadency and differences was there observed is further apparent from the fact that whilst such was the practice of the House of Orleans, the House of Anjou carried a bordure gules, and that of Alençon a bordure gules charged with eight bezants. In Germany, Sir George Mackenzie says that the several branches of great families distinguish themselves only by different crests, and he gives as the reason that all the sons succeed equally to the honors of the family. In Britain and in France some change is always made on the shield as carried by the head of the house; but the practice even of good heralds has been so irregular as to bring the rule very nearly to what Mackenzie holds to be the correct one—viz., that every private person should be allowed, with the sanction of the proper authorities, "to make what marks of distinction can suit best with the coat which his chief bears." See *Cadency* and *Heraldry*.

DIFFERENTIAL PULLEY-BLOCK. — The portable hoisting-device generally known by this name was invented some twenty years ago. It secured immediately great popularity, and its use extended rapidly throughout the civilized world, wherever modern machinery was known and appliances for lifting heavy weights were needed. No previous device had ever embodied the same conveniences, namely, great lifting power and the ability to hold the load suspended at any point, and the accomplishment of these ends by a machine of great simplicity, compactness, and of light weight. The universal adoption, throughout the world, of the Weston differential pulley-block as the standard type of portable hoists is due to the fact that it perfectly meets all of these requirements and in the simplest possible way. Since its introduction other machines have been invented for similar uses, but no one of them combines in itself the important

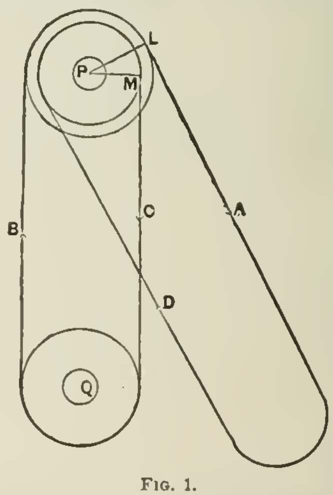


FIG. 1.

characteristics of power, safety, simplicity, and portability to a degree which equals that of the Weston block. The latter is demonstrably a reduction of the problem to its simplest possible form, and therefore can never be superseded. In recent text-books it is given a place among the other mechanical powers or elements, thus recognizing the fundamental character of its design and usefulness.

The principle of the device is very ancient, but it is only recently that it has been embodied in a machine of practical utility. In designing any mechanical power the object to be aimed at is this, that while the power moves over a considerable distance, the load shall only be raised a short distance. When this object is attained we then know by the principle of energy that we have gained an increase of power. The principal points of this machine will be understood from Fig. 1 and Fig. 2. It consists of three parts—an upper pulley-block, a movable pulley, and an endless chain. We shall briefly describe them. The upper block, P, is furnished with a hook for attachment to a support. The sheave it contains resembles two sheaves, one a little smaller than the other, fastened together; they are in fact one piece. The grooves are furnished with ridges which prevent the chain from slipping around them. The lower pulley, Q, consists of one sheave which is also furnished with a groove. It carries a hook to which the load is attached. The endless chain performs a part that will be understood by the arrow-heads attached to it in the figure. The chain passes from the hand at A up to L, over the larger groove in the upper pulley, then downwards at B, under the lower pulley, up again at C, over the smaller groove in the upper pulley at M, and then back again by D to the hand at A. When the hand pulls the chain downwards, the grooves of the upper pulley begin to turn together in the direction shown by the arrows on the chain. The large groove is therefore winding up the chain while the smaller is lowering.

In the pulley which has been employed in the experiments to be described the effective circumference of the large groove is found to be 11.84 inches, while that of the small groove is 10.36 inches. When the upper pulley has made one revolution the large groove must have drawn up 11.84 inches of chain, since the chain cannot slip on account of the ridges; but in the same time the small groove has lowered 10.36 inches of chain; hence, when the upper pulley has revolved once, the chain between the two must have been shortened by the difference between 11.84 and 10.36 inches, that is, by 1.48 inch; but this can only have taken place by raising the movable pulley through half of 1.48 inch, that is, through a space of .74 inch. The power has then acted through 11.84 inches and has raised the resistance .74 inch. The power has therefore gone through a space 16 times greater than that through which the load moves. In fact it is very easy to verify by actual trial that the power must be moved through 16 feet in order that the load may be raised 1 foot. We express this by saying that the velocity ratio is 16. By applying power to the chain, D, proceeding from the smaller groove, the chain is lowered by the large groove faster than it is raised by the small one, and the lower pulley descends. The load is thus raised or lowered with great facility by simply pulling one chain, A, or the other, D.

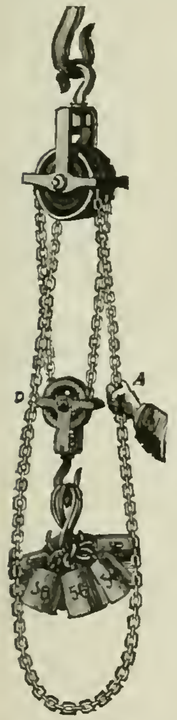


Fig. 2.

We shall next consider the mechanical efficiency of the differential pulley-block. The block which we shall use is intended to be worked by one man and will raise any weight not exceeding a quarter of a ton. We have already learned that for the load to be raised 1 foot the power must act through 16 feet. Hence were it not for friction we should infer that the power need only be the sixteenth part of the load. A few trials will show us that the real efficiency is not so large, and that in fact more than half the power exerted is merely expended upon overcoming friction. This will lead afterwards to a result of considerable practical importance. Placing upon the load-hook a weight of 200 pounds, we find that 38 pounds attached to a hook fastened on the power-chain is sufficient to raise the load; that is to say, the power is about $\frac{1}{5}$ of the load. If we make the load 400 pounds we find the requisite power to be 64 pounds, which is only about 3 pounds less than $\frac{1}{6}$ of 400 pounds. We may safely adopt the practical rule that with a differential pulley-block of this class a man will be able to raise a weight six times greater than he could raise without such assistance.

A series of experiments carefully tried with different loads have given the results shown in the following table:

Circumference of large groove, 11.84 inches; of small groove, 10.36 inches; velocity ratio, 16; mechanical efficiency, 6.07; useful effect, 38 per cent; formula $P = 3.87 + .1508R$.

Number of Experiment.	R. Load in pounds.	Observed power in pounds.	P. Calculated power in pounds.	Difference of the observed and calculated values.
1	56	10	12.3	+ 2.3
2	112	20	20.8	+ .8
3	168	31	29.2	− 1.8
4	224	38	37.7	− .3
5	280	48	46.1	− 1.9
6	336	54	54.6	+ .6
7	392	64	63.1	− .9
8	448	72	71.5	− .5
9	504	80	80.0	.0
10	560	86	88.4	+ 2.4

The first column contains the numbers of the experiments; the second, the weights raised; the third, the values of the corresponding powers. The calculated values of the powers are given in the fourth column, and the differences between the observed and calculated values in the last column. The differences do not in any case amount to 2.5 pounds, and considering the size of the loads raised (up to a quarter of a ton), the formula represents the experiments with satisfactory precision.

Suppose, for example, 280 pounds is to be raised; the product of 280 and .1508 is 42.22, to which when 3.87 is added we find 46.09 to be the requisite power. The mechanical efficiency found by dividing 46.09 into 280 is 6.07. To raise 280 pounds 1 foot, 280 foot-pounds of energy would be necessary; but in the differential pulley-block 46.09 pounds must be exerted for a distance of 16 feet in order to accomplish this object. The product of 46.09 and 16 is 737.4. Hence the differential pulley-block requires 737.4 foot-pounds of energy to be applied to it in order to produce 280 foot-pounds; but 280 is only 38 per cent of 737.4, and therefore with a load of 280 pounds only 38 per cent of the energy applied to a differential pulley-block is utilized. In general we may state that not more than about 40 per cent is profitably used, and that the remainder is employed in overcoming friction.

It is a very remarkable and useful property of the differential pulley that a weight which has been hoisted by it will remain suspended, without any tendency to run down; this is a point of great practical convenience. The reason why the load does not run down in the differential pulley may be thus explained. Let us suppose that a weight of 400 pounds is to be raised 1 foot by the differential pulley-block; 400 units of work are necessary, and therefore 1000 units of work must be applied to the power-chain to produce the 400 units (since only 40 per cent is utilized). The friction will thus have consumed 600 units of work when the load has been raised 1 foot. If the power-weight be removed, the pressure supported by the upper pulley-block is diminished. In fact, since the power-weight is about $\frac{1}{6}$ of the load, the pressure on the axle when the power-weight has been removed is only $\frac{5}{6}$ of its previous value. The friction is produced by the pressure of the pulleys on their axles and is nearly proportional to that pressure; hence when the power has been removed the friction on the upper axle is $\frac{5}{6}$ of its previous value, while the friction on the lower pulley remains unaltered. We may therefore assume that the total friction is at least $\frac{5}{6}$ of what it was before the power-weight was removed. Will friction allow the load to descend?

600 foot-pounds of work were required to overcome the friction in the ascent: at least $\frac{6}{7} \times 600 = 514$ foot-pounds would be necessary to overcome friction in the descent. But where is this energy to come from? The load in its descent could only yield 400 units, and thus descent by the mere weight of the load is impossible. To enable the load to descend, we have actually to aid the movement by pulling the chain D (Figs. 1 and 2), which proceeds through the small groove in the upper pulley.

The principle which we have here established extends to other mechanical powers and may be stated generally. Whenever rather more than half of the applied energy is uselessly consumed by friction, the load will remain suspended without overhauling. See *Cranes*, *Hoisting-machines*, and *Tramrail*.

DIFFERENTIAL WINDLASS.—A windlass whose barrel consists of two portions of varying diameters. The rope winds on to one as it winds off the other, the effect of a revolution being governed by the difference between the circumferences of the two portions. If it wind on to the larger and off of the smaller the load is elevated, and conversely. See *Chinese Windlass*.

DIKES.—Dikes and bridges, used in fortification, in no way differ in principle from similar constructions used elsewhere. The communication across the enceinte-ditch leading from the gateway is usually an ordinary wooden bridge. The bay of this bridge at the gateway is spanned by a drawbridge of timber, which when drawn up closes and secures the gateway. This drawbridge is manuevered by some of the usual mechanisms employed for this purpose; and for convenience of maneuvering should not be longer than 12 feet. Care should be taken that it should fit the recess in the face of the wall so closely that there will not be room enough between it and the jambs of the gateway to insert a crowbar to force back the bridge. See *Bridges* and *Communications*.

DILLICH SYSTEM OF FORTIFICATION.—In this system the ravelins before the bastion are replaced by counterguards and the counterscarp of the main ditch is directed on the shoulder-angles. The low flanks are casemated on the Italian method. In another system Dillich adopts the tenaille-tracing.

DIMACHÆ.—In ancient times a kind of horsemen, answering to the dragoons of the moderns.

DIMIDIATION.—In Heraldry a mode of marshaling arms, adopted chiefly before quartering and impaling according to the modern practice came into use, and subsequently retained to some extent in Continental though not in English Heraldry. It consists in cutting two coats of arms in half by a vertical line, and uniting the dexter half of the one to the sinister half of the other. Coats of husband and wife were often so marshaled in England in the thirteenth and fourteenth centuries. Mr. Planché traces the double-headed eagle of the German Empire to a dimidiated coat, with half an eagle for the Eastern and another half for the Western Empire. See *Heraldry*.

DIMINISH.—In a military sense, to decrease the front of a battalion; to adopt the columns of march, or maneuver according to the obstructions and difficulties which it meets in advancing.

DIMINISHED ANGLE.—In fortification, the angle formed by the exterior side and the line of defense.

DIMINUTIONS.—A word sometimes used in Heraldry for differences, marks of cadency, and brisures, indifferently.

DIOPHANTINE ANALYSIS.—That section of the theory of unlimited or indeterminate problems which attempts to find rational and commensurable values answering to certain equations between squares and cubes. This class of problems was first and chiefly treated of by Diophantus, who has given his name to the theory of their solution. We shall not here attempt to explain the nature of the analysis, which is very subtle and guided by few general rules. The difficulties of the solution of diophantine problems in most cases fail to be overcome by the skill and ingenuity of the analyst. We confine ourselves to stating the following examples of the problems solved by the diophantine analysis: 1. To find two whole numbers the sum of whose squares is a square. 2. To find three square numbers in arithmetical progression. 3. To find a number from which two given squares being severally subtracted, each of the remainders may be a square. Solutions of problems in gunnery are frequently accomplished by this analysis.

DIOPTRICS.—That branch of geometrical optics which treats of the transmission of rays of light from one medium into another, differing in kind. It consists of the results of the application of geometry to ascertain in particular cases the action of what are called the laws of refraction. When a ray of homogeneous light is incident upon a surface, the angle which its direction makes with the normal or perpendicular to the surface at the point of incidence is in dioptrics, as in catoptrics, called the angle of incidence. The angle which the refracted ray makes with the same line is called the angle of refraction. This being premised, we may state the laws of refraction. 1. The incident and refracted ray lie in the same plane with the normal, at the point of incidence, and on opposite sides of it. 2. The sine of the angle of incidence, whatever that angle may be, bears to the sine of the angle of refraction a constant ratio dependent only on the nature of the media between which the refraction takes place, and on the nature of the light. According to the second law, if we call the angle of incidence i, and that of refraction r, we shall have $\sin i = \mu \sin r$, where μ is a quantity depending upon the nature of the media and of the light. It will have, for instance, a certain value for refraction from vacuum into glass, another from glass into water, and so on; also, it will have one value for red light, another for green, and so on. The quantity μ is called the refractive index, and is greater than 1 when refraction takes place from vacuum into a medium, and in general is greater than 1 when the refraction is from a rarer into a denser medium, and less than 1 when the opposite is the case. In dioptrics the laws of refraction may be considered as depending for their truth upon experiment; in physical optics they are deductions from an hypothesis respecting the constitution of light. They are not merely approximately true; they are absolute physical laws.

Before proceeding to consider the simpler leading cases of refraction, one or two interesting propositions in dioptrics require to be explained. 1. If the refractive index for a medium, when light is incident upon it from vacuum, be μ, and the index for another medium, under the same circumstances, be μ', then, when light proceeds from the second medium into the first, the refractive index is $\frac{\mu}{\mu'}$. The proof of this proposition depends upon the two following experimental laws: (1) If a ray of light proceed from a point to a second, suffering any reflections or refractions in its course, then, if it be incident in the reverse direction, i.e., from the second point, it will follow the exactly reverse course to the first point. This is proved by experiment, but may be accepted as axiomatic. (2) If a ray pass from vacuum through any number of media, having their faces plane and parallel, when the ray emerges into vacuum its direction will be parallel to that which it had before incidence. To deduce the proposition from these laws, let i be the angle of incidence from vacuum upon the first medium, r the angle of refraction, which will also be the angle of incidence upon the second medium. Also let r' be the angle of refraction into the second medium, which will also be the angle of incidence upon the second bounding surface. By the second of the preceding experimental laws, the angle of emergence into vacuum will be i. Hence we shall have, by the first of these laws, $\sin i = \mu' \sin r$ at the first surface, and $\sin i = \mu \sin r'$ at the second. From these equations we have sin

$r = \frac{\mu}{\mu'} \sin r'$, which proves the proposition. It follows that if μ be the refractive index from vacuum into a medium, that from the medium into vacuum will be $\frac{1}{\mu}$. 2. Our second proposition relates to what is called the *critical angle*. If i be the angle of incidence of a ray within a medium, the refractive index of which is μ, and r the angle of refraction into vacuum, then we have from the former proposition $\sin i = \frac{1}{\mu} \sin r$. From this formula, if i be given, r may be found, and a real value will be given to r so long as $\sin i$ is $< \frac{1}{\mu}$; but when i has a value greater than that determined by the equation $\sin i = \frac{1}{\mu}$, the formula fails to give us a value of r, for the sine of an angle cannot be greater than 1. And experiment shows that, in fact, there is no refracted ray when the angle of incidence is greater than that above assigned, the ray being wholly reflected within the medium. The angle of which the sine is $\frac{1}{\mu}$ is called the *critical angle*. For glass it is about 41 45; for water, about 48° 30'. This angle is sometimes called the angle of *total reflection*. In internal reflection at the surfaces of media, the reflected light is more nearly equal in intensity to the incident than in any other case of reflection. While it thus appears that refraction from a denser into a rarer medium is not always possible, it may be added that it is always possible from a rarer into a denser.

We shall now investigate some simple cases of refraction. 1. In case of refraction at a plane sursurface. Let DIMN (Fig. 1) be any medium bounded by a plan, DI, and let R be a radiant point and RD and RI two incident rays of a divergent pencil proceeding from R to the surface of the medium; then RD being perpendicular to the surface suffers no refraction, but proceeds along DM within the medium; but RI is refracted in the direction IN, which, produced outwards, meets the normal DF in F.

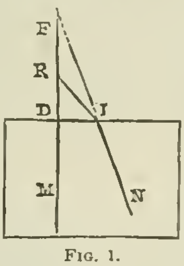


Fig. 1.

Therefore a small pencil of rays proceeding from R, and having RD, perpendicular to the surface, for axis, will be refracted into another pencil diverging from the imaginary focus F; for all the rays intermediate between RD and RI will converge very near F when the pencil is small. An eye within the medium, and between N and M, would thus, the pencil being small, see the luminous point R as if it were at F, or further off than it really is. In the opposite case, in which the luminous point is within the refracting medium, similar reasoning shows that after the rays emerge from the plane surface into the air they will, if the pencil be small, appear to proceed from an imaginary focus nearer to the surface than the luminous point. 2. The case of refraction through a prism, which we are next to consider, is, in fact, but the case of refraction through a medium bounded by plane surfaces which are not parallel. Conceive any two planes at right angles to the plane of the paper, and making on that plane the figure BAC (Fig. 2). The question is as to the laws of transmission of a ray, SPQR, of homogeneous light through the prism. Draw mn' and $n'n$ perpendicular to the sides. Then $n'PQ$ and $n'QP$ are respectively the angles of refraction at the first, and

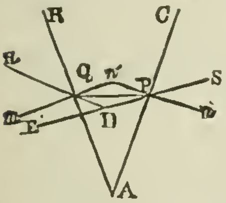


Fig. 2.

of incidence at the second surface. Now, as n QA and n'PA are each of them right angles, and as all the angles in the figure n QAP are equal to four right angles, it follows that the angles at n' and at A together are equal to two right angles. But the angle at n, together with the angles n PQ and n QP, are equal to two right angles; therefore must the angles n PQ and n QP together be equal to the angle at A. In other words, in refraction through a prism: *The sum of the angles of refraction at the first surface, and of incidence at the second, is equal to the angle contained between the plane sides of the prism.* From this it might be shown that the deviation of a ray caused by passing through a prism is always towards the thicker part of the prism, if the medium be denser than the surrounding atmosphere. It is a geometrical proposition which the student may solve for himself, that if i be the angle of incidence at the first surface, and e that of emergence at the second, and if α be the angle of the prism, then σ, or the change of direction of the ray in its passage, is obtained from the formula $\sigma = i + e - \alpha$. 3. We now take up the case of refraction at a single spherical surface of a medium denser than the surrounding air. And first, of parallel rays refracted at a convex spherical surface. Let ABQP (Fig. 3) be the refracting medium, whose terminating convex surface is spherical, C being the center of the surface, while V is its vertex.

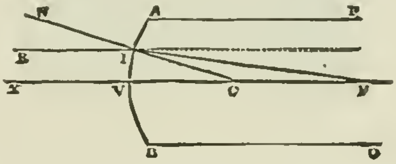
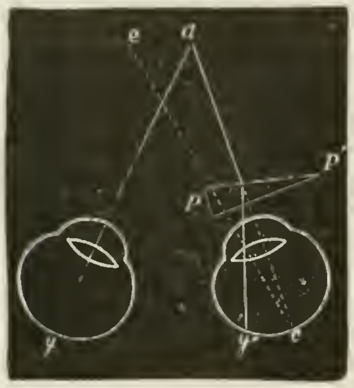


Fig. 3.

Let XV be the axis of a pencil of parallel rays, of which any ray, RI, is incident at I. Then, if CIN be a normal, the angle of refraction, CIF, will be less than the angle of incidence, RIN, and the refracted ray will thus turn towards the axis, and meet it at some point, F. When the pencil is small, or the aperture, AVB, of only a few degrees, the rays will clearly nearly all converge to the same point, F. To find the position of F, we have, in the triangle ICF, the angle CIF = r, the angle of refraction, and ICF, the supplement of ICV or NIR (by parallel lines), i.e., of i, or the angle of incidence. Therefore IF : CF : : sin i : sin r. And as for a very small pencil IF may be taken = VF, we have FV : FC : : sin i : sin r, or : : μ : 1. And putting FV = F, the principal focal distance, and VC = R, we have $F = \frac{\mu}{\mu - 1} R$. If the medium be crown-glass, for which the value of μ is $\frac{3}{2}$, we have $F = \frac{\frac{3}{2}}{\frac{3}{2} - 1} R$, or F = 3 R; i.e., the principal focal distance is equal to three times the radius of the sphere. The student may, by similar reasoning, ascertain for himself the focus of parallel rays incident on a concave spherical refracting surface, as also the focus in the case of a pencil of parallel rays within the medium and emerging from it. The case of a divergent pencil is incapable of such elementary treatment as to justify its insertion here. For branches of the subject treated under separate heads the reader should refer to the articles Caustic, Lens, and Refraction. Under Refraction he will find a table of the values of μ—the refractive index—for various media and kinds of light. See *Catoptrics* and *Chromatics*.

DIP.—1. A name sometimes given to the superior slope of a parapet. 2. The inclination of the sole of an embrasure. 3. The slight downward inclination of the arms of an axle.

DIPLOPIA.—To insure correct and comfortable vision the two eyes must work in unison; for if the rays of light do not fall on a corresponding spot of the retina of each eye, two objects instead of one will be seen, as represented in the drawing. Diplopia, or double-sight, is caused by weakness of the muscles which move the eye from side to side. They are no longer able to hold the two eyes steadily fixed toward the object, and the eye moving out or in causes the individual to see the object double. This can often be very much relieved by prismatic lenses. Paresis of the ciliary muscle is the inability to maintain the adjustment of the eyes for near objects any length of time without fatigue; for instance, in reading or sewing, especially by insufficient light, the fatigued ciliary muscle relaxes and the accommodative power of the



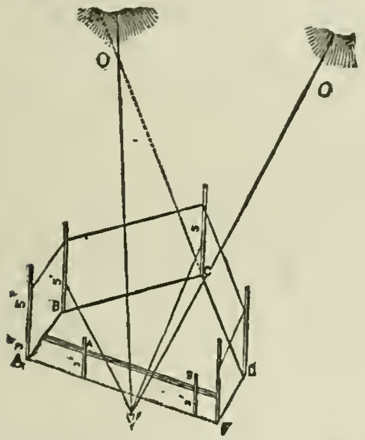
eyes is suddenly lost, causing the print or work to become confused and unintelligible, together with a feeling of fatigue and pain about the eyeballs. In such cases, after a few minutes' rest and closing the eyes, work can be resumed but for a short time only, as the muscle will again lose its strength and relax. This disagreeable trouble arises from a debilitated condition of the whole system, which, though not felt in other parts of the body, is apparent in the muscle of accommodation, on account of its position and the character of the work it is called upon to perform. After a fit of illness, or a great shock causing nervous prostration, this difficulty is often apparent. Persons whose eyesight had been previously perfect should not resort to glasses of any kind when affected with these spasms of the sight, but wait patiently until nature does the work by restoring the tone of the whole system. This advice does not apply to those who have this same trouble that arises from a hypermetropic form of the eye, and not from the cause mentioned above. A skilled oculist, on examination, would at once detect the cause and prescribe the remedy. See *Myopia*.

DIPPING-NEEDLE.—If a magnetic needle be supported so as to be free to move vertically, it does not at most places on the earth's surface rest in a horizontal position, but inclines more or less from it. If the vertical plane in which the needle moves is the magnetic meridian of the place, the angle between the needle and the horizontal line is called the dip or inclination of the needle. The dip of the magnetic needle at any place can be ascertained with very great exactness by means of the dipping-needle. It consists of a graduated circle fixed vertically in a frame, and moving with it and a vernier on a horizontal graduated circle. This last is supported by a stand furnished with leveling-screws. At the center of the vertical circle there are two knife-edges of agate, supported by the frame, and parallel to the plane of the circle. The needle rests on these knife-edges by means of two fine polished cylinders of steel, which are placed accurately at the center of the needle, and project at right angles from it; so adjusted, the needle moves with little or no friction. It is so made, moreover, that before being magnetized it remains indifferently in any position; after magnetization, therefore, the dip which it shows is wholly due to the magnetic influence of the earth. In order to understand how an observation is made with the dipping-needle, we must regard the directing force of the earth's magnetism exerted upon the poles of the needle in any vertical plane in which it may happen to be, as resolved into two forces, one acting at right angles to the plane, and the other acting in the plane. There being a corresponding but opposite force at each pole, we have thus two statical couples acting on the needle—one tending to turn it at right angles to the plane in which it moves, and the other tending to bring it round to a position in the plane such that the needle and the forces of the couple may be in a line. In the dipping-needle the mode of support completely neutralizes the first of the couples ; and the position that the needle takes in any plane is due wholly to the second. When the plane of the needle is at right angles to the magnetic meridian, the forces of this latter couple act vertically, and bring the needle to the same position. This, then, gives us the means of determining the magnetic meridian, for we have only to bring the vertical circle round till the needle stands at 90° to put it in a plane at right angles to that meridian ; and then by moving the vernier on the horizontal circle over 90° we place the upper circle and needle in the plane of the magnetic meridian. The dipping-needle thus serves the purpose of a declination-needle. In bringing the needle round from the plane at right angles to the magnetic meridian, the dip is less and less, till it becomes least in the plane of that meridian. We might thus also find the magnetic meridian, for it is that plane in which the dip of the needle is least. When the needle is in the plane of the magnetic meridian, the couple which acts in other vertical planes at right angles to them disappears, and the whole force of the terrestrial magnetism acts at each pole of the needle, forming a couple which swings the needle round till it stands in a line with itself. The degree on the circle then pointed to by the needle is the dip at the place of observation. Two readings are necessary, for the reason stated under DECLINATION-NEEDLE. One reading is taken,

the needle is then reversed so as to change its supports, and then a second reading is noted, and the mean of the two gives the correct reading. The position of the needle when the dip is read off is manifestly the same that a needle suspended in air, if that were possible, and free to move in any way, would finally assume. In resolving, therefore, the total directive force of the earth as we have done above, we must keep in mind that it always acts parallel to the direction of the dipping-needle. See *Inclination-needle*.

DIPPING OF THE MUZZLE.—When a piece of artillery is fired, the action at the vent brings increased pressure on the elevating-screw or quoin. The reaction from this naturally throws down the muzzle.

DIRECT DEFILEMENT.—The direct defilement of a work may be practically performed on the ground as follows: Let A B C D F be the plan of a work, a lunette for example; and the points O, O, etc., lying within the angle formed by the prolonged direction of the two faces B C, D C, the most elevated points of a commanding position in front of the work. At the points A, B, etc., let straight poles be planted vertically, and on the poles along the gorge-line let a point be marked, at three feet above the ground. Let two pickets be driven in the ground along the gorge-line, and a cord, A B, or a straight-edge of pine, be fastened to them on the same level as the two points marked on the poles at A and B. Let an observer now place himself in the rear of A B, so as to bring the poles at B, C, and D, and the points O, O, etc., within the same field of vision. Let observers be placed at B, C, and D. The first observer now sights along A B until he brings his eye in the position that A B will appear tangent to the most elevated of the points O. Having accurately determined this position, he next directs the other observers to slide their hands along the poles until they are brought into the same plane of vision with the point O and the line A B, and to mark those points on the poles. These points, together with the two first marked, will evi-



Plan of Work, A B C D F, showing the manner of Defiling it from the Heights, O, O, lying in front of its faces.

dently be in the same plane, and this plane, produced, will be tangent to the highest point O. It is denominated the *rampant plane*. Now if a point be marked on each pole at five feet above the points thus determined, these points will be contained in a second ideal plane, parallel to the first, and five feet above it. This plane is denominated the *plane of defilement*, and the interior crests of the work are contained in this plane, being the lines joining the highest points marked on the poles. As the gorge-line is farthest from the heights, and the rampant plane ascends towards them, it will necessarily pass at more than three feet above every other point of the parade of the work; and the plane of defilement, in like manner, will pass at eight feet above the parade at the gorge, and at five feet above the highest point O. A plane of front defilement is therefore defined to be that plane which, containing the interior crests of a work, passes at least eight feet above every point of the parade, and at least five feet above every point that the enemy can occupy within the range of cannon. See *Defilement* and *Plane of Defilement*.

DIRECT EMBRASURE.—When the directrix of an embrasure is perpendicular to the direction of the parapet, the embrasure is termed *direct*. The form, dimensions, and construction of the embrasure in mask-walls present a problem which has offered no little difficulty, in a satisfactory solution, to engineers, by which the best cover could be given to the guns and men by exposing the least surface to embrasure-shots, whilst the guns should receive a suitable traverse to command a wide field of fire. In the embrasures of our works the general form is the same as those usually found in Europe, but they present a very considerably less amount of exterior and throat opening than European embrasures. In some of our earlier works the sole, cheeks, and top of the embrasures are constructed of brick, as being a material that would be less destructive from the splinters driven in by embrasure-shots. This view, however, has been abandoned in our more recent works, the embrasures being constructed, on the contrary, of heavy stone blocks carefully and strongly bonded; a brick arch being thrown above the embrasure within the mass of the mask-wall to secure the upper portion from yielding, should the block forming the ceiling of the embrasure be damaged. See *Embrasure*.

DIRECT FIRE.—*Direct* or *horizontal fire* is where the piece is discharged having but a small angle of elevation, and the projectile strikes the object without touching the intermediate ground. A fire is said to be *direct*, *slant*, or *enfilading* according as its direction is perpendicular to, makes an angle of 30° with, or is on the prolongation of the line at which it is aimed; when the line is taken in the rear the fire is denominated a *reverse fire*; and when a given space is defended by the fire from several points crossing over it, the defense is denominated a *cross fire*.

DIRECTING-CIRCLE.—To form a gabion, a *directing-circle* is made of two hoops, the difference between their radii being such that, when placed concentrically, there shall be about 1$\frac{3}{4}$ inch between them. They are kept in this position by placing small blocks of wood between them, to which they are tied with pack-thread. The directing-circle is placed on the ground, and seven or nine stakes, about 1 inch in diameter and 3 feet long, are driven slightly into the ground between the hoops, at equal distances apart; the directing-circle is then slipped up midway from the bottom, and tied in that position. Twigs about half an inch in diameter, and as long as they can be procured, are wattled between the stakes like ordinary basket-work. When finished to within about 2 inches of the top, the gabion is placed with the other end up, the directing-circle taken off, and the gabion completed to within 2 inches of the other extremities of the stakes. The wicker-work at the two ends is secured by several withes, and the ends of the pickets are sharpened. The gabion is then ready for use. See *Gabion*.

DIRECTING-SERGEANT.—When a company is being drilled in marching, a Sergeant distinguished for precision in marching is selected, who is called a Directing-sergeant, and placed in front of the guide on the line established. This Sergeant is charged with the direction and step, and marches on points selected by himself directly in front of him. The right guide of the company marches straight in the trace of the Directing-sergeant.

DIRECTION.—1. In gunnery, the path or course a projectile takes when fired from a gun. The path pursued may be either a *good* or *bad* direction, with reference to the points aimed at. 2. That element of pointing which relates to the movement of the piece around an imaginary vertical axis. The direction is given when the plane of sight passes through the object. Elevation is a movement about a horizontal axis. See *Pointing*.

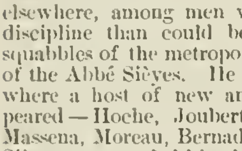
DIRECTOR OF ARTILLERY AND STORES.—An officer in the English service appointed by the Secretary of State for War to assist the Controller-in-Chief. His duties are confined to all questions relating to the manufacture, provision, supply, and maintenance of munitions of war.

DIRECTOR OF SUPPLIES AND TRANSPORT.—An officer in the English service appointed by the Secretary of State for War to assist the Controller-in-Chief. This officer has to deal with all questions relating to the provision and supply of food, forage, fuel and light, lodging and transport.

DIRECTORY.—Upon the death of Robespierre, in

1794, a reaction commenced in the Convention itself, as well as throughout all France, against the sanguinary excesses of the Terrorists. Ultimately a new Constitution—that of the year 3 (1795)—gave birth to a new government, composed of a legislative body divided into two Councils; the Council of Five Hundred, whose function was to propose laws; and the Council of the Ancients, whose function was to pass them. The actual executive power was intrusted to five members chosen from both sections, and who sat at the Luxembourg. Their names were Lépeaux, Letourneur, Rewbel, Barras, and Carnot. These five constituted the famous *Directory*. They assumed authority in a moment of immense peril. France was environed with gigantic adversaries, while distrust, discontent, and the malice of rival factions made her internal administration almost hopeless. The frantic heroism of her soldiers saved her from spoliation by the foreigner; and had all the members of the Directory been patriotic and honest, she might have been saved also from spoliation by her own children. But, on the contrary, the home-policy of the Directory was deplorable. The demoralization which had begun to characterize officials even in Danton's time now seized almost every class. Barras, a representative of all the turpitude of the hour, set the example. The majority of the two Councils were equally corrupt; and although there were some both in the Councils and Directory whose virtues and talents were unimpeachable, yet they were too weak to counteract the knavery of their associates. It soon became clear that France could not be reconsolidated by the fag-ends of the Revolution. The power and skill requisite for such a herculean work must be sought for elsewhere, among men who had received a nobler discipline than could be obtained in the political squabbles of the metropolis. Such was the thought of the Abbé Sièyes. He turned his eyes to the army, where a host of new and brilliant names had appeared — Hoche, Joubert, Brune, Kleber, Desaix, Massena, Moreau, Bernadotte, Augereau, Bonaparte. Sièyes propounded his plan for the overthrow of the Directory, and the establishment of a Consulate, that should be, in reality, a Monarchy under republican forms, first of all to Moreau, who was frightened by its audacity; then to Bernadotte, whose excessive caution hindered him from approving of it; then to Augereau, who could not understand it; and finally to Bonaparte, on his return from Egypt. The last admired the project; a conspiracy was rapidly formed; all those functionaries who had been promised places by the Directory, but had not received them, offered their aid; and by the *coup d'état* of the 18th Brumaire an end was put to a government of weakness, immorality, and intrigue. It was succeeded by the Consulate.

DIRECTRIX.—1. The center line in the plane of fire of an embrasure or platform. See *Embrasure*. 2. A right line perpendicular to the axis of a conic section in reference to which its nature may be defined. Assuming the indefinite line AB in the figure as the directrix, and F a point without it as a focus, then if the line FD revolves about F as a center, while a point D moves in it in such a manner that its distance from F shall always be to CD, its perpendicular distance from the line AB, in a constant ratio, then the curve VD, described by the point D, is a conic section, and is an ellipse, a parabola, or an hyperbola according as FD is less than, equal to, or greater than CD, or FV than VA. The constant ratio referred to is called the determining ratio of the conic.



DIRK.—A variety of dagger or poniard worn by Highland regiments. It is at present worn by officers rather for ornament than for use, though in former days it was a valuable weapon. The *dirk-knife* is a clasp-knife having a large, dirk-like blade.

DISABILITY.—1. State of being disabled; want of competent physical or intellectual power. When a soldier becomes disabled from exposure, accidents, or other causes, he is discharged from the service on a Surgeon's Certificate of Disability, which enables him to draw a pension. 2. Legal disability is either absolute, which wholly disables the person from doing any legal act—e.g., outlawry, excommunication, attainder, alienage—or partial, such as infancy, coverture, lunacy, drunkenness, and the like. It may arise from the act of God, of the law, of the individual himself, or of his ancestor, or the person from whom he inherits.

DISABLING CANNON.—If necessary to abandon *matériel*, it must be disabled or destroyed, so as to be useless to the enemy. Guns are permanently disabled by bursting, bending the chase, breaking off the trunnions, or by scoring the surface of the bore; they are temporarily disabled by spiking, breaking off the sights and the seat for the hausse, or in breech-loaders by carrying off or permanently destroying the breech-blocks, etc.

To burst a cast-iron gun, load with a heavy charge, fill the bore with sand or shot, and fire at a high elevation. To bend the chase of a bronze gun, fire a shotted piece against another, muzzle to muzzle or muzzle to chase; or kindle a fire under the chase and strike on it with a sledge-hammer. To break off a trunnion of a cast-iron cannon, strike on it with a heavy hammer or fire a shotted gun against it. To score the surface of the bore and injure the rifling, cause shells to burst in the gun or fire broken shot from it with high charges.

To spike a gun, drive into the vent a jagged and hardened steel spike with a soft point, break it off flush with the vent-field, and clinch it in the bore with the rammer; a nail without a head, a piece of ram-rod, or even a plug of hard wood may be used in the absence of a spike. To prevent the spike from being blown out, make a projectile fast in the bottom of the bore by wrapping it with cloth or felt, or by means of iron wedges driven in with a rammer or with an iron bar; if the wedges were of wood they could be easily burnt out by a charcoal-fire lighted with a pair of bellows.

When it is expected to retake a gun, use a spring spike with a shoulder to prevent its coming out too readily. Mitrailleurs are permanently disabled by bending the barrels, etc.; they are made temporarily useless by removing the crank-handles, locks, etc. Carriages are destroyed by piling them up and burning them; to prevent them from moving, the spokes and poles may be cut or sawed off. Ammunition-chests are blown up or water is poured over their contents. Implements are carried off or destroyed.

To unspike a gun, try to drive the spike into the bore with a punch; if there be a shot wedged in the bore, expel it by powder inserted through the vent. When it is impossible to drive down the spike, if the bore be unobstructed, insert a charge of one third the weight of the projectile, and ram down junk wads with a handspike, first placing on the bottom of the bore a strip of wood with a groove on the lower side containing a strand of quick-match by which the charge is ignited; this plan will not answer when the spike is screwed or riveted into the vent. In a bronze gun, remove some of the metal at the upper orifice of the vent, and pour sulphuric acid into the cavity before firing. Should the preceding methods fail, after several trials, drill out the spike, or drill a new vent if the gun be iron; if it be bronze, unscrew the vent-piece.

To drive out a shot wedged in the bore, unscrew the vent-piece, if there be one, and drive in wedges so as to start the shot forward, then ram it back again, and with a hook withdraw the wedges that may have held it; or pour in powder and fire it after replacing the vent-piece. As a last resort, bore a hole in the bottom of the breech, drive out the shot, and stop the hole with a screw. See *Spike* and *Unspike*.

DISARM.—The act of depriving a body of troops of arms for some gross misconduct or crime which renders dismissal from the service necessary. The Indian Mutiny in 1857–58 affords instances of whole regiments being disarmed and disbanded. Other regiments, at the same time, apparently loyal, were simply disarmed, to prevent the chance of the men falling upon their officers.

DISARRAY.—Want of array or regular order; likewise to throw into disorder or to break the array of.

DISBANDING.—In military matters, the breaking up of a regiment or corps. When peace is proclaimed after a war, and a reduction of the army becomes necessary, this is effected by disbanding or disembodying; the men are discharged and the officers are mustered out or placed on half-pay.

DISBURSING OFFICERS.—Officers whose special functions are to make disbursements of public moneys. The regulations governing this class of officers are very properly and necessarily rigid. The following are duly enforced in the United States service:

If any Disbursing Officer bets at cards or any game of hazard, his Commanding Officer suspends his functions, requires him to turn over all the public funds in his keeping, and immediately reports the case to the proper Bureau of the War Department. In every case where an officer intrusted with the care or disbursement of public funds violates this regulation, he is brought to trial before a General Court-Martial by the Department Commander, and is not assigned to duty, or again put in possession of public funds subsequent to his trial, without the approval of the Secretary of War.

Every officer charged with the payment of any of the appropriations made by any Act of Congress, who pays to any clerk, or other employé of the United States, a sum less than that provided by law, and requires such employé to receipt or give a voucher for an amount greater than that actually paid to and received by him, is guilty of embezzlement, and is fined in double the amount so withheld from any employé of the Government, and is imprisoned at hard labor for the term of two years.

Every person who, having charge, possession, custody, or control of any money or other public property used or to be used in the military service, who, with intent to defraud the United States or willfully to conceal such money or other property, delivers or causes to be delivered to any other person having authority to receive the same, any amount of such money or other property less than that for which he received a certificate or took a receipt, is imprisoned at hard labor for not less than one nor more than five years, or fined not less than one thousand nor more than five thousand dollars.

If any officer charged with the disbursement of the public moneys accepts, receives, or transmits to the Treasury Department, to be allowed in his favor, any receipt or voucher from a creditor of the United States, without having paid to such creditor in such funds as the officer received for disbursement, or in such funds as he may be authorized by law to take in exchange, the full amount specified in such receipt or voucher, every such act is an act of conversion, by such officer, to his own use, of the amount specified in such receipt or voucher.

Every officer of the United States, and every person acting for or on behalf of the United States, in any official capacity under or by virtue of the authority of any department or office of the Government thereof, who asks, accepts, or receives any money, or any contract, promise, undertaking, obligation, gratuity, or security for the payment of money, or for the delivery or conveyance of anything of value, with intent to have his decision or action on any question, matter, cause, or proceeding which may, at any time, be pending, or which may be by law brought before him in his official capacity, or in his place of trust or profit, influenced thereby, is punished by a fine not more than three times the amount asked, accepted, or received, and by imprisonment not more than three years. And if he hold any place of profit or trust, forfeits his office or place; and is thereafter forever disqualified from holding any office of honor, trust, or profit under the United States.

The sureties to the bonds to be given by Disbursing Officers are bound jointly and severally for the whole amount of the bond, and must satisfy the Secretary of War that they are worth jointly double the amount of the bond, by the affidavit of each surety, stating that he is worth, over and above his debts and liabilities, the amount of the bond or such other sum as he may specify; and each surety states his place of residence. See *Public Moneys*.

DISCHARGE.—1. The action of firing off a charge from a piece of ordnance or small-arm. Guns were formerly discharged by priming-powder poured into the vent, or by quick-match, which was ignited by means of slow-match or port-fire. Friction-tubes have for some years past been introduced into the service, and have been found to be vastly superior in power and certainty of ignition to either of the above modes, and are now universally used. Breech-loading small-arms are discharged by means of a needle or piston coming in contact with detonating composition at the base of the cartridge.

2. A release from military service either under compulsion or authority. There are several classes of discharge. First, on a soldier having completed the term of service for which he engaged, and not wishing to renew his services. This is either completion of limited engagement or service for pension. Second, when permitted to purchase his discharge. Third, when disabled from wounds or sickness to serve any longer. Fourth, when discharged by sentence of Court-Martial to penal servitude. Fifth, when discharged with ignominy for some offense that brings dishonor on the corps. Sixth, when summarily discharged as a worthless and incorrigible character. In England, a discharge from the military service is by right at the expiration of the period for which attested; or earlier, by indulgence. In the latter case the grant may be gratuitous, as on reduction of numbers, or when the man is not worth retaining, or paid for by the man discharged. In the last case the soldier pays a sum of money computed with reference to the unexpired period of service. If a soldier has many years still to serve, the discharge-purchase may amount to as much as £20. In the Sappers and Miners, where the men are all artisans, it may amount to £35; and among this Corps such discharges are very frequent, on account of the value placed on the services of these intelligent men by private employers. Soldiers are, under the Act of 1870, frequently discharged from service in the regular forces, after three or six years therein, on condition of serving the remainder of their original term in the Reserve. Earl Grey, when Colonial Secretary, introduced the plan of enabling discharged soldiers to settle on a piece of land in the Colonies instead of returning home. Soldiers are occasionally "discharged with ignominy," for some offense that brings dishonor on the corps. In such case the regiment is assembled, the crime recapitulated, and the sentence read. The buttons, facings, chevrons, medals, and all decorations are cut from the man's uniform, and he is "drummed out" of the regiment, if a foot-soldier, or by sound of trumpet, if it be a cavalry regiment. Notice of his degradation is afterwards sent in writing from the War Office to his parents or relations.

In the United States service no enlisted man is discharged before the expiration of his term, except—1. By order of the President, or Secretary of War, or the Commanding Officer of a Department. 2. By sentence of a General Court-Martial. 3. On certificate of disability by the Commander of a Geographical Department or an army in the field. 4. By order of one of the United States Courts, or Justices or Judges thereof, on writ of *habeas corpus*. The authority of State Courts to issue writs of *habeas corpus* in this matter is not recognized. 5. General service clerks may be discharged by their Commanders. When an enlisted man is to be discharged, his Company Commander furnishes him certificates of his account or final statements. And to *insure* his being at the post to get these, no leave of absence, terminating with his service, is given to him. The cause of discharge, and the soldier's age *at its date*, are stated in the body of the discharge-certificate. The soldier's character is carefully described according to the facts. Whenever the man is unfit for re-enlistment because of bad conduct, the space in the discharge-certificate left for description of character is cut off. The officer signing the character on the discharge-certificate of an enlisted man states thereon whether or not the soldier is married. Insane soldiers are not discharged at the posts where they may be serving, but are discharged by the Secretary of War after their arrival at the Government Hospital for the Insane. The Company Commanders forward with their descriptive lists, and accounts of pay and clothing, certificates of disability in the usual form, and a medical history of the cases for the information of the Superintendent of the Hospital. An honest and faithful service of twenty years in the army entitles a soldier to admission to the Soldiers' Home; but applications for discharge by reason of twenty years' service are not entertained unless the soldier is a fit subject for discharge on certificate of disability, or upon condition that he shall enter the Soldiers' Home.

DISCIPLINE.—Under a perfect discipline, troops in peace and in war, in garrison or in campaign, would be fitted for all the duties of war. To attain this perfection, it is necessary that discipline should rest entirely upon law; it ought to have its roots in patriotism; to be adapted to the character of the people; to the spirit of the age, and the nature of the government. It is essential to make rights and duties inseparable. This absolute necessity, and the importance of regularity of pay, are truths dwelt upon by the French writers. Discipline may be distinguished as active and passive. The first derives its power from a military hierarchy or range of subordination, skillfully established and regulated; it is secured by calmness, impartiality, promptness, firmness, and the prestige of character in officers. These qualities are manifested by preventing wrongs rather than by punishing faults, and by abstaining from arbitrary corrections when obliged to chastise. Discipline, intrusted to such authorities enlightened by military experience, will partake of the character of paternal government, and will not be enforced with an unsparing harshness suited only to governments essentially despotic.

The dogma that military discipline can only be sustained by the aid of severe and unpitying punishment is far removed from the idea here suggested. That unpitying military discipline seems to have prompted Peter the Great when he sacrificed a young officer who triumphantly fought the Swedes without orders. Thus also thought Frederick the Great when he executed the unfortunate Zietten, who violated an order by keeping a light a little too long in his tent. But such harsh principles are no longer inculcated in the best-governed armies of Europe. Passive discipline is the fusion of individual interest in national interest. The first military virtue is *esprit de corps*, with fidelity to the oath taken upon assuming the military character. These duties exact obedience to the laws, and to the lawful orders of the President of the United States, and officers set over us according to law. These laws should command obedience from all inferiors, and distinctly define the extent of all authority. They ought to bind the President or Commander-in-Chief as well as the simple soldier. Rights and duties must be reciprocal, and be alike established by law, which should, to maintain discipline, "precisely determine the functions, duties, and rights of all military men—Soldiers, Officers, Chiefs of Corps, Generals." Discipline that has attained this perfection supplies the deficiency of numbers, and gives new solidity to valor; since, although surrounded by dangers, the brave man feels that his leaders and comrades are not less devoted, less vigorous, or less experienced than himself.

Discipline is sometimes used as meaning "system of instruction," but its signification is much broader. Its technical military sense includes not only the means provided for exercise and instruction, but subjection to all laws framed for the government and regulation of the army. The good or bad discipline of an army depends primarily upon the laws established for its creation, as well as its government and regulation.

DISCRETION.—This term includes prudence, wisdom, the liberty of acting at pleasure, uncontrolled and with unconditional power; all which qualities, if wisely directed, will contribute much, in military affairs, to the successful termination of all undertakings. The military phrase, *to surrender at discretion*, implies surrendering without stipulation, throwing one's self on the mercy of a victorious enemy.

DISEMBARKATION.—The act of landing troops, arms, and supplies from a boat or ship. When this can be done at a wharf, it is simply the reverse operation of embarking. When wharf-accommodations are not available, arrangements will have to be made for transferring the men, horses, and *matériel* from the vessel to the shore. An army or other considerable body of troops embarked for an expedition, to be landed under such circumstances, will be provided with general means for disembarking, and the artillery, which usually constitutes an important feature of the outfit, shares with the rest in these general arrangements; but, owing to its nature, much of a special character is required for it, demanding the most careful consideration and attention from Artillery Officers. Such expeditions usually embark at seaports where there are accommodations that make the operation comparatively simple and easy, and for this reason the many preparations necessary for landing on an open shore are apt to be overlooked, or to be inadequately provided for. It becomes the especial province of the Artillery Commander to look out for this, and to give his advice and make his wants known to the Army Commander, so that the latter may cause proper provision to be made. The following method for the disembarkation of an army corps proved successful during the War of the Rebellion, and the same, or some modification of it, will apply in every case.

The essential articles for forming a landing-place were, several canal-barges; a number of ponton-boats, with balks, chess, oars, anchors, etc., complete; a number of gang-planks; a plentiful supply of lumber, and the necessary amount of ground-tackle, cordage, and tools. The canal-barges were about 14 feet wide and 70 to 80 feet long (drawing, when loaded, 5 feet of water; when light, 2 feet), and of about 80 tons burden. The gang planks were from 12 to 30 feet long and 10 feet wide, and very strong; ropes were attached to their corners, and the larger ones furnished with rollers. By lashing two of the canal-barges together, placing the boats some 12 feet apart, and throwing a false or additional deck over the whole, a platform was formed about 40 feet wide and 45 feet long, capable of holding all the pieces and caissons of a six-gun field-battery, or from forty to fifty horses. This boat or raft, when thus loaded, drew about 4 feet of water. Several of these rafts were prepared for the purpose of forming a *wharf-head*, alongside of which vessels could lie and discharge. From this wharf-head to the shore a ponton-bridge was constructed. The operation of disembarking consisted in bringing the transports alongside of the wharf-head, placing a gang-plank from the deck to the gunwale, and another from the gunwale to the wharf-head. Over these gang-planks the horses were led and taken ashore. The guns, caissons, and other carriages were run down the gang-plank and over the bridge by hand. In this way but two or three hours were consumed in disembarking an entire battery.

For disembarking artillery by this method or indeed by any method, smooth or comparatively smooth water is a *sine qua non*. Infantry and even artillery *matériel*, may be landed with small boats or lighters through a heavy surf, but a smooth sea is required for horses. When it is not considered expedient to construct a wharf-head and bridge, and the water near shore is of sufficient depth, double canal boats may be used for rafts to disembark both horses and *matériel*. The rafts must have railing around them; this should be strong, the stanchions extending into the boats and secured throughout with bolts and nuts. The horses are loaded from the vessel onto the raft either by means of gang-planks or by slinging them. The raft is towed to the shore by small boats or, better, by a small steam-tug; a gang-plank is run out and the horses led ashore. The guns and caissons are brought ashore in the same manner. When canal-barges are not to be had, small coasting-schooners may, by removing their deck-hampers, be used instead. Large decked-over scows, such as are to be found in seaport towns, make excellent rafts. When the distance from the vessel to the shore does not exceed 1000 yards or thereabouts, a warp-line may be used for bringing back and forth the raft. Every exertion should be made to erect a wharf, rough and temporary though it be, using for the purpose any kind of boats or scows that can be obtained. It may sometimes be advisable to sacrifice a ship for the purpose of forming a wharf-head, by scuttling and sinking her in such depth of water as to leave her spar-deck three or four feet above high water. With a sandy or muddy bottom, a ship might be sunk by loading her down until she rests firmly on the bottom. If the weather is calm she will suffer no great injury, and can be floated off when no longer required. The business of constructing rafts and wharfs as described belongs, as a general rule, to the Engineers; but should the Artillery Commander of an expedition anticipate, even in the remotest degree, a failure to provide the requisite means for disembarking, it becomes his duty to look after it, and he cannot be too zealous in doing so. The best plan under such circumstances is for each transport to carry along with it an outfit capable of discharging its cargo. The most useful boat for lightering that can be carried is the wooden ponton, such as is used for military bridges. It is 31 feet long, 5.5 feet wide at top, 4.5 feet wide at bottom, and 2.5 feet deep. Besides the three men required for managing it, it is capable of carrying 40 infantrymen with their arms and knapsacks, and it will very readily carry six horses.

Each transport should carry four ponton-boats and all the equipment for two rafts. If there is not sufficient room on deck for the boats, they may be carried stowed flat to the sides of the ship, bottom outwards, resting on strong solid chocks bolted to the wales. A strong parbuckle-sling passes around each, with which it is hoisted into place by the yard and stay purchases, and secured by lashings; by the same means it is lowered into the water. With several transports, each carrying the above-described outfit, it is generally practicable, by combining all, to form a bridge. Suitable vessels can nearly always be obtained for forming the wharf-head.

When there are several transports unloading at the same time, conspicuous and well-understood signal-marks must be placed opposite each, on the beach, so that it may be known to what points to direct the boats and rafts without confusion. A strong party for each should be on shore to secure the rafts upon touching, to haul up the guns and caissons, and to take care of the horses. Unless there is some special reason to the contrary, horses will always be landed first. This gives them an opportunity of resting and recovering from the trip while the *matériel* is being landed.

As a last resort, the horses may be swum ashore, and the *matériel* landed in the ship's boats—a very tedious operation. The horse is lowered over the side by slinging; a boat must be in attendance below to unhook the fall and clear the sling. A man in the small boat takes him by the halter and, conducting him a short distance, gives him the proper direction to the shore; without this precaution, horses sometimes become bewildered and swim around the vessel until exhausted. When the deck of the vessel is low, say not over ten feet, and there is a gangway, the horses may be backed off into the water without slinging. This method should not, however, be resorted to if it can possibly be avoided; it is liable to strain and injure the animal, and will ever after make him timid and shy about taking the water when it is necessary to cross streams on the march.

Siege-guns are embarked and disembarked in the same general manner as light field-pieces. When gang-planks are used, they are hauled up or let down by means of tackle. When embarking from a wharf or raft without gang-planks, the piece is run with its carriage under the ship's tackle; the gun is slung and hoisted aboard and lowered onto the deck or into the hold. In disembarking, the carriage is first put upon the wharf or raft, under the ship's tackle, and the piece then lowered onto it.

When it is necessary to land heavy guns by means of lighters, or from small vessels, the latter may be beached at high tide; the pieces are raised by blocking and skids until they can be rolled down two inclined skids from the vessel to the beach, where they are received upon skids or blocks of sufficient size to prevent them from burying themselves in the sand. At low tide they are removed from the beach.

Sieges, and similar operations calling for the use of the heavier classes of ordnance, are usually of such a protracted nature as to allow of substantial wharves being constructed, and cranes, derricks, and shears provided for unloading weighty *matériel*. It is but loss of time and labor, often ending in failure, to proceed with imperfect arrangements of this kind.

The disembarkation of an army must be considered under two heads: 1st. When made without any chance of interruption from any enemy; 2d. When made in presence of an enemy, or where an attack is possible. So far as artillery is concerned, the first of these conditions has been discussed in the foregoing paragraphs, and it will not be necessary to enter into further details here.

With regard to the latter, all questions, political, strategical, or otherwise, entering into the object of the expedition, having been settled by the proper authorities, and the army for carrying it out having been organized, embarked, and the transports arrived within the general limits of the field of operations, the first thing to be decided upon is the exact place or places where the various parts of the command are to be put ashore. Many local circumstances will influence this decision; among the most important of which will be to secure good anchorage and depth of water near the shore, a general configuration of ground in front which will admit of its being swept by the fire of the fleet, a firm and commodious beach, and freedom from prevailing winds or currents which may interrupt the disembarkation. The fire of the fleet must clear the country in front. The infantry is first landed and immediately pushed out sufficiently far to keep the enemy beyond cannon-range of the landing-place; here it intrenches itself, forming a *tête-de-pont* around the landing.

Meanwhile preparations will be made for landing the batteries. All the boat-rafts will be put together, and if a wharf-head and floating bridge is to be constructed it will be commenced at once. Steam-tugs must be in attendance for towing the rafts, carrying orders, and other miscellaneous duties. The Artillery Commander designates the order in which the batteries are to disembark, and will see that the transports take proper positions for effecting this without causing intervals of unnecessary delay.

If the attacks of the enemy are formidable and persistent, demanding the immediate service of artillery, the guns of several or of all the batteries may be landed without their horses, and taken to positions on the line by hand, or by the horses of one of the batteries landed for that special purpose.

When the expedition is large and the number of transports, store-ships, etc., great, the worst of confusion will arise unless some system of marking and distinguishing them is adopted. The best method is for each one to carry, instead, of her own burgee, the distinguishing flag of the corps to which the troops on board belong. This will show at a glance whether they are infantry, artillery, or cavalry, and to what corps, division, and brigade they belong. Besides this, each vessel should have a number painted, as large as possible, on each quarter. When embarking, a memorandum is kept and furnished to Commanding and Staff Officers showing what troops are on board of each transport. The Chief of Transports, who should be a Quartermaster selected for his practical capacity in such business, designates the anchorage-ground for each part of the command, and sees that they move up at the proper time and in the required order to the place of debarkation. It is with him that the Artillery Commander communicates in reference to the movements of the artillery transports. See *Transports.*

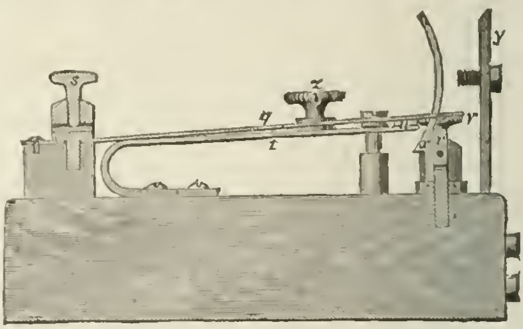
DISEMBODY.—To disarm a military body, and to dispense with its services for any stated period. The disembodying of the militia is an instance in point.

DISENGAGE.—1. To separate the wings of a battalion or regiment, which is necessary when the battalion counter-marches from its center and on its center by files. 2. To clear a column or line which may have lost its proper front by the overlapping of any particular division. 3. To extricate one's self and the troops commanded from a critical situation. 4. To break suddenly from any particular order in line or column, and to repair to some rallying-point. 5. In bayonet-exercise or fencing, to quit that side of an enemy's blade on which one is opposed by his guard, in order to effect a cut or thrust where an opportunity may present. The movement is executed as follows: Being engaged in *tierce*, number two covered, the Instructor commands: 1. *Number one*, 2. DISENGAGE. Number one passes his bayonet quickly under the bayonet of number two, to the left side, and lunges as explained for the *lunge in quarte*. Number two, as soon as he loses the touch of his adversary, executes the *quarte*, *prime*, or *butt-parry*, and then thrusts or lunges at command. Being engaged in *quarte*, number two covered, number one disengages from the left to the right side, and lunges as explained for the *lunge in tierce*. Number two, as soon as he loses the touch of his adversary, parries in *tierce* or *seconde* and then thrusts or lunges at command. See *Bayonet-exercise* and *Engage.*

DISGRACEFUL CONDUCT.—In the army this term implies conduct unbecoming an officer or soldier, and includes the following crimes: fraudulently misapplying public money or stores; malingering and feigning disease; willfully maiming or mutilating; maiming or injuring another soldier; tampering with eyes; stealing or feloniously receiving; offense of a felonious or fraudulent nature upon a civilian; indecent assault; producing false or fraudulent accounts or returns. For each of which crimes an officer or soldier can be tried by a General Court-Martial.

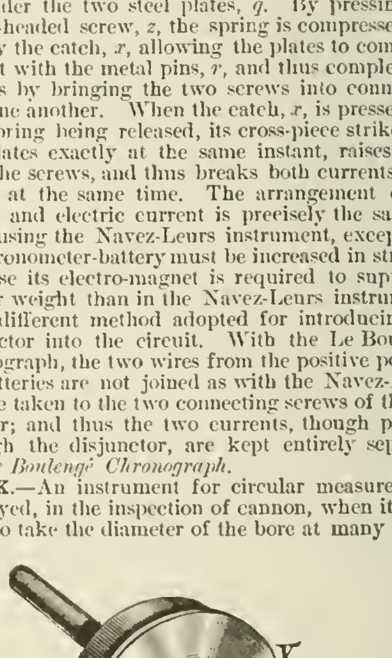
DISH OF A WHEEL.—The inclination or angle with the nave given to the spokes of a gun-wheel. The most severe stress to which spokes are subject is from the lateral thrust brought to bear upon the nave when one wheel becomes lower than the other by slipping into a rut, etc. In order, therefore, to place them in a better position to resist this thrust, the wheel is "dished," or formed into a kind of dome; and just as the dome or arch is strong, from its form, to resist pressure upon the crown tending to crush it in, so is the wheel made strong by the dish to resist the lateral thrust tending to force the nave outwards. In fact, not only do the spokes, sustained by the tire, yield mutual support to each other, but the lateral thrust upon each becomes partly converted into a compressing strain, which the wood has better power to resist. The greater the dish, the stronger the wheel will be to resist the lateral strain; but no more dish should be given than necessary for the safety of the spokes. See *Archibald Wheel* and *Wheel.*

DISJUNCTOR.—This important apparatus, as applied to the chronoscope and shown in the drawing in section, is composed of a mainspring, *t*, carrying a



cross-piece covered with insulating material, and passing under the two steel plates, *q*. By pressing the milled-headed screw, *z*, the spring is compressed and held by the catch, *x*, allowing the plates to come into contact with the metal pins, *r*, and thus complete the circuits by bringing the two screws into connection with one another. When the catch, *x*, is pressed, the mainspring being released, its cross-piece strikes the two plates exactly at the same instant, raises them from the screws, and thus breaks both currents identically at the same time. The arrangement of the screws and electric current is precisely the same as when using the Navez-Leurs instrument, except that the chronometer-battery must be increased in strength (because its electro-magnet is required to support a greater weight than in the Navez-Leurs instrument), and a different method adopted for introducing the disjunctor into the circuit. With the Le Boulengé chronograph, the two wires from the positive poles of the batteries are not joined as with the Navez-Leurs, but are taken to the two connecting screws of the disjunctor; and thus the two currents, though passing through the disjunctor, are kept entirely separate. See *Le Boulengé Chronograph.*

DISK.—An instrument for circular measurements employed, in the inspection of cannon, when it is desired to take the diameter of the bore at many points



of the circle. There is a brass tompion, V, to fit the muzzle of the gun, with a hole through its center to receive the staff of the star-gauge. It is turned to fit snugly the bore of the piece, into which it enters two or three inches, to hold it firmly in place; and has a projecting flange or face to prevent it going in too far.

The face is a plane surface with its circumference divided into as many equal parts as may be thought desirable, and numbered in regular order. On the staff of the star-gauge a brass slide, X, is fitted, having a thumb-screw to hold it in any position: from its inner end an arm, Z, extends at right angles to the staff, of sufficient length to meet the points on the circumference of the disk and having a center-line marked upon it. This slide is secured at any distance on the staff at which a circular measurement is desired, and with the center-line of the arm coinciding with the center-line of the staff; when the arm will indicate the direction of the pair of measuring-points; being in the same plane with them.

The disk is secured in the muzzle, with its zero-mark coinciding with a light punch-mark on the muzzle-face directly below the *line of sight*, so that it is in a plane passing through the axis of the piece and perpendicular to the axis of the trunnions. To take the measurements, press the staff home until the arm of the slide comes in contact with the face of the disk, and turn it to coincide with the various divisions of the disk at which measurements are desired. The disk is divided into halves, and the center-hole is reinforced on the inside by a projection, which is turned to receive a collar that fits closely around it, and holds the two halves together when they are placed on the staff. See *Inspection of Ordnance* and *Star-gauge*.

DISLODGE.—In a military sense, to drive an enemy from the position he has taken up.

DISMANTLE.—To render fortifications incapable of defense by razing them to the ground.

DISMISSION.—No sentence of a Court-Martial in time of peace dismissing a Commissioned Officer, or which, in war or peace, affects a General Officer, can be carried into execution without the approval of the President of the United States. Disbursing Officers may be dismissed by the President alone, without the intervention of a Court-Martial, on failure to account properly for moneys placed in their hands. A General Court-Martial in time of peace may dismiss, with the approval of the President, in all cases in which they are authorized to sentence to "death or such other punishment as may be inflicted by a General Court Martial." Such Court may also sentence a Commissioned Officer to be cashiered or dismissed the service. In the English service, dismissal is the sentence passed upon an officer by a Court Martial for conduct which renders him unfit to remain in the army. From the date of publishing the order the dismissed officer's connection with the army ceases. It is in the power of Her Majesty to dismiss any officer from the service without bringing him to trial.

DISMOUNT.—1. A word of command, in the School of the Soldier mounted, for mounted men to leave the saddle. To execute the command, rise upon the left stirrup; pass the right leg extended over the croup of the horse without touching him; bring the right heel to the side of the left; descend lightly to the ground; remove the left foot from the stirrup, and place it by the side of the right, keeping the body erect; let go the mane; pass the end of the reins over the pommel of the saddle with the right hand, which then seizes the left rein. (Two.) Face to the left, take two short steps, left foot first; slip the right hand along the left rein, and take the position of *stand to horse*. See *Mount*.

2. In artillery, to take a piece of ordnance off its carriage. With light guns it is performed by the gun's crew with the aid of drag-ropes. With heavy guns, gins and jacks have to be resorted to; but guns of moderate weight can be dismounted by means of tackles, rollers, and handspikes.

3. Guards, when relieved, are said to dismount. They are marched with the utmost regularity to the parade-ground where they are paraded, and from thence to their regimental or company parades, previously to being dismissed to their quarters.

DISOBEDIENCE OF ORDERS.—A crime severely punished in all armies. In the United States the Articles of War provide that any officer or soldier who, on any pretense whatsoever, strikes his Superior Officer, or draws or lifts up any weapon, or offers any violence against him, being in the execution of his office, or disobeys any lawful command of his Superior Officer, shall suffer death or such other punishment as a Court-Martial may direct.

DISPART.—In gunnery, the dispart is generally defined as a patch of metal placed on the highest point of the muzzle of a gun or howitzer, and which is half the difference between the diameter of the base-ring and that of the swell of the muzzle. This definition will only strictly apply to cast-iron and bronze ordnance. Most of the *dispart-sights* or *patches* are not placed near the muzzle, but on the top of the gun, a little in advance of the trunnions; or, as with rifled guns, just above the trunnions. A better definition for dispart would then be, half the difference between the diameter of those parts of the gun upon which the sights are placed. The term is derived from the mode of ascertaining the dispart, as shown above, and disparting (dividing in two) the difference between the two diameters, which *half* difference shows the tapering or coning of the metal between the base ring and swell of the muzzle. This patch of metal is intended, in laying the piece, to avoid the inconvenience arising from the line of sights or metal not being parallel to the axis of the gun. Disparts are either fixed or movable. See *Sight*.

DISPART-SIGHT.—A gun-sight, made to allow for the dispart, and bring the line of sight and the axis of the piece into parallelism. See *Dispart*.

DISPATCHES.—Official messages. In war, important dispatches which have to pass through the enemy's country, or in the vicinity of his forces, are only intrusted to officers to whom their contents can be confided. Dispatches are frequently in cipher, especially when telegraphed or signaled with a liability to interception. See *Cryptography*.

DISPERSE.—In a military sense, the power which an armed body, either better handled or in larger numbers, has of scattering a hostile force drawn up to oppose it. Cavalry, under these circumstances, forms a prominent part in pursuing or dispersing the enemy.

DISPLACED.—A term, in the British service, applied to officers who are sometimes removed from a particular regiment in consequence of misconduct, but who are at liberty to serve in any other corps.

DISPLAY.—A military term meaning to extend the front of a column, and thereby bring it into line.

DISPLAYED.—In Heraldry, a term meaning *expanded;* as, an eagle displayed, or what is commonly known as a spread eagle. See *Heraldry*.

DISPLUME.—In a military sense, to deprive of decoration or ornament; to degrade.

DISPOSITION.—In military language, as applied to the strategic position of troops, is of infinite consideration both in war and time of peace. In the former case, a knowledge of the country in which the campaign is to be fought, and the various combinations which should be carried out, formed on the disposition of the troops, is very necessary on the part of the General in command, to bring matters to a successful termination, or to prevent the enemy from taking advantage of a bad disposition of his opponent's forces to harass or break them up. The following maxims from the memoirs of General Montecuculi are worth remembering:

"Deliberate leisurely, execute promptly.

"Let the safety of your army be ever first.

"Leave nothing to chance.

"Take advantage of circumstances.

"Use all the means in your power to secure a good reputation."

DISPOSITION DE GUERRE.—Warlike arrangement or disposition. Under this head may be considered the mode of establishing, combining, conducting, and finally terminating a war, so as to produce success and victory.

DISRESPECT.—In a well-disciplined army disrespect is not tolerated. The Articles of War provide that any officer or soldier in the United States army who uses contemptuous or disrespectful words against the President, the Vice President, the Congress of the United States, or the Chief Magistrate or Legislature of any of the United States in which he is quartered, or who behaves himself with disrespect towards his Commanding Officer, shall be punished as a Court-Martial may direct.

DISTANCE.—1. The space between the observer and any object. In gunnery, *to judge distance* accurately is a high qualification in artillerymen, as well as in soldiers of the line, and is only to be attained by a clear sight, constant observation, and practice in the drill laid down on this subject, termed "judging distance drill," the introduction of which into the army has been attended with such excellent results. Under the most favorable circumstances, however, judging distances by the eye is not to be depended upon, and this is so much felt in the artillery service that to each gun a range-finder will doubtless be attached, giving the distance of objects very accurately, and rendering it unnecessary to depend on the eye.

2. A term in tactics, expressing the relative space left between troops in the ranks, after a formation or movement. *Distance* is estimated perpendicularly to the front, while *interval* is estimated parallel to the front. When mounted, the following distances are approved: distance between companies in column of fours is 9 yards (front of four troopers, plus 5 yards); distance between companies in column of platoons is platoon front, plus 5 yards; distance between companies in column of companies is company front, plus 5 yards; in echelon of companies, distance between companies is company front, plus 5 yards; in echelon formed from line of platoon column, distance between companies is platoon front, plus 5 yards; in echelon of double columns, distance between companies is 9 yards; distance between companies in close column is 12 yards; full distance between companies in double column of fours is ½ company front, plus 9 yards; closed distance between companies in double column of fours is 9 yards; full distance between companies in column, double rank, is front of company in single rank, plus 1 yard; closed distance between companies in column, double rank, is front of company in double rank, plus 1 yard; interval between companies in line, single or double rank, is 8 yards; full interval between companies in line of platoon columns is company front, plus 8 yards, less the front of one platoon; closed interval between companies in line of platoon columns is 12 yards; full interval between companies in line of double columns is front of company in line; closed interval between companies in line of double columns is ½ front of company in line; full interval between companies in line of companies in columns of fours is front of company in line, plus 4 yards; half interval between companies in line of companies in columns of fours is ½ front of company in line, plus 4 yards.

DISTANCE OF THE BASTION.—In fortification, a general term applied to the exterior polygon.

DISTANT DEFENSE.—A defense consisting in being able to interrupt the enemy's movements by circuitous inundations; to inundate, for instance, a bridge when a convoy is passing, or to insulate batteries, the heads of saps, or lodgments which have been made in the covered-way. By this species of defense an enemy's communications may be perpetually intercepted, and his approaches so obstructed as to force him to leave dangerous intervals.

DISTLLATION.—The separation of a body from extraneous substances by its conversion into vapor, its removal in that state, and its subsequent condensation. The operation is termed *distillation* if the vapor assumes the form of liquid upon condensation, even if that liquid should solidify upon further cooling. The vessels used for distilling are few and simple; those for raising the temperature of the water are generally of metal, and termed *stills*. A still consists of a boiler to contain the liquid, to which is adapted a head terminating in a beak, which fits into the condensing apparatus. There are several forms of condensers in general use—among them the *Worm* and the *Liebig*.

DISTORTED SECTION.—The name applied to a method of approximately determining the center of gravity of a gun by experiment. A figure differing from a longitudinal half-section of the gun by the substitution in the place of the ordinates representing semi-diameters of those proportionate to the squares of the diameters is cut from cardboard or other material of uniform weight for a given area. In this a point of suspension from which the axis assumes a horizontal position is readily found by trial, and its position relative to the length of the figure is the same as that of the center of gravity in the gun. In the application of the method a convenient scale for the length of the gun and for abscissas in the line of its axis is one tenth. For the ordinates it will usually be convenient to take one hundredth of the square of semi-diameters. The principles involved will hardly need explanation. *Areas* are made to correspond to volumes, and occupy the same relation to the center of gravity. An extension of the plan gives a means of ascertaining approximately the *weight* of a gun. It will be found that the area of the figure drawn on the scale proposed presents one square inch for every 3141.6 cubic inches of volume of the gun. The area may conveniently be found by comparing the weight of the irregular piece of cardboard with that of a carefully measured rectangular piece cut from the same sheet. The volume of the gun being found in cubic inches, the only remaining step to find its weight is, of course, to multiply by the weight per cubic inch. Cardboard of the better sort is commonly very uniform in weight in parts of the same sheet. See *Center of Gravity*, and *Centrobaric Method*.

DISTORTION.—The rules of perspective impose certain conditions in the delineation of natural objects, and when the image formed by a lens on the focusing-screen of a camera obscura does not fulfill those conditions, it is said to be distorted. The effect of distortion is to render all straight lines which do not pass through the center of the lens curvilinear, and also so to alter the relative proportions of objects in the picture as to be opposed to the principles of true perspective. Distortion, in the camera obscura, is generally produced by the eccentrical incidence of the oblique pencils.

DISTRIBUTION.—In a general military sense, any division or allotment made for the purposes of war; also minor arrangements made for the supply of corps.

DISTRICT.—The term Military District is applied to one of those portions into which a country is divided for the convenience of command and to insure a co-operation between distant bodies of troops. Before Mr. Cardwell's Act of 1872 England was divided into four Districts, and Ireland into five, while Scotland formed one. Now there are nine general Districts in England—namely, the Northern, with Manchester as its headquarters; the Eastern, with Colchester; the Southern, Portsmouth; the Southeastern, Dover; the Home District, London; the Chatham; the Woolwich; the Aldershott. In Ireland there are four—Belfast, Dublin, Cork, and the Curragh. Scotland is still one District, with Edinburgh as headquarters. Jersey is a Military District; and Guernsey and Alderney form another.

DISVELOPED.—A term in Heraldry applied to the colors of a regiment or army, which are said, heraldically, to be disveloped when flying. Also written *Developed*.

DITCH.—The ditch, sometimes called *fosse*, is the excavation made round the works, from which the earth required for the construction of the rampart, parapet, and banquette is obtained. In besieging a fortification, when the ditch is dry, and a descending gallery has been constructed, the passage of the ditch consists of an ordinary sap pushed from the opening in the counterscarp-wall to the slope of the breach, and, when necessary, it is carried on to crown the summit of the breach. If the ditch be full of water, and the locality favors its being drained, every means must be used to break the batardeaux, to cause the water to flow away entirely or in part. If none of the batteries can see the batardeaux, the sluices must be sought and destroyed by shells, or by mining. Should the assailants be unable to breach the batardeaux or to destroy the sluices, a bridge or causeway must be thrown across. This is one of the most difficult operations in a siege. The bridge or causeway, with its epaulement, is constructed with pontons or casks, or, if without them, with fascines, hurdles, gabions, and sand-bags, openings being left in the causeway to allow the free flowing of the water, if it be a running stream, or can be made so by the defenders. A wet ditch may sometimes be crossed by a raft of sufficient length, which should be constructed along the counterscarp, and attached by one end to the bottom of the descent. The raft is then allowed to swing round with the current, if there be one, or is rowed or pulled round, if there is not one, so as to form a connection across the ditch with the breach.

The ditch should be regulated to furnish the earth for the parapet. To determine its dimensions the following points require attention: its depth should not be *less than six feet*, nor its width *less than twelve feet*, to present a respectable obstacle to the enemy. It cannot, with convenience, be made *deeper than twelve feet;* and its greatest width is regulated by the inclination of the superior slope, which, produced, should not pass *below the crest of the counterscarp.* If we assume the height and thickness of the parapet, we can calculate the dimensions of the ditch as follows: Denote by R the volume of the parapet, S the area of the profile of the parapet, and l the right line generated by the center of gravity of the profile of the parapet, supposing this profile moving parallel to itself, and generating the volume of the parapet under consideration. Denote by R', S', and l' similar quantities for the ditch. The volumes for the parapet and the ditch, for any part of the work under consideration, will be expressed as follows:

$$R = S \times l \quad \text{and} \quad R' = S' \times l'. \quad . \quad . \quad (1)$$

Earth when made into an embankment occupies a greater space than it did in the natural state. Denote this increase of volume by $\frac{1}{m}$. Since the volume of the earth in embankment is furnished by the volume excavated from the ditch, there results

$$R = R'\left(\frac{m+1}{m}\right). \quad . \quad . \quad . \quad . \quad . \quad (2)$$

Substituting in equation (2) the values taken from equations (1), there results

$$S' = S\frac{l}{l'}\left(\frac{m}{m+1}\right). \quad . \quad . \quad . \quad . \quad (3)$$

It will be sufficiently exact to take l' equal to the length of the middle line of the ditch; which being substituted gives S' in known terms. Assume the slope of the scarp $\frac{1}{3}$ and the counterscarp $\frac{1}{4}$ greater than the natural slope. Represent the width of the ditch at top by x, and its depth at the middle by y. Denote the angle of the natural slope by φ. Using this notation, the area of the profile of the ditch is given as follows:

$$S' = y\left(x - \frac{7}{12}y \cot \varphi\right). \quad . \quad . \quad . \quad (4)$$

Solving equation (4) with respect to x, there results

$$x = \frac{7}{12}y \cot \varphi + \frac{S}{y}; \quad . \quad . \quad . \quad . \quad (5)$$

and solving with respect to y, and taking the minus sign of the radical, it gives

$$y = \frac{6}{7} \tan \varphi \left(x - \sqrt{x^2 - \tfrac{7}{3}S' \cot \varphi}\right). \quad . \quad (6)$$

From these equations (5 and 6) y can be assumed and x deduced, or x assumed and y deduced. Making $\varphi = 45°$, these last equations reduce to

$$x = \frac{7}{12}y + \frac{S'}{y} \quad \text{and} \quad y = \frac{6}{7}\left(x - \sqrt{x^2 - \tfrac{7}{3}S}\right).$$

It should be remembered, in assuming values for x and y, that x must not be less than twelve feet, and y not less than six nor greater than twelve feet. In practice it will be sufficiently accurate to calculate the area of the assumed profile, assume a depth for the ditch, and, without making an allowance for the increase of volume of the earth in the embankment, divide the area of the profile by the assumed depth of the ditch. The result will give the width of the ditch at the top.

DITCH-DEFENSES.—There are two kinds of arrangements employed on the exterior of a parapet to add to the strength of a work; viz., the arrangements made to defend the ditch, and those made to obstruct an enemy's approach. The term *ditch-defense* is used to designate the arrangement made exterior to the parapet by which a fire is made to sweep the ditch. The term *obstacle* is applied to any construction or arrangement, whatever may be its nature, which, by its passive resistance, obstructs the approach of an enemy advancing to assault the work. Hence anything is an obstacle which diverts the attention of the enemy from the assault to the immediate surroundings of himself. The surest defense for a ditch is a good flanking arrangement of the work itself; but as this is, in many cases, impracticable, owing either to the relief or to the plan, flank-defenses must be procured by a construction made in the ditch. Several methods may be resorted to for this purpose, the structures being termed *caponieres, scarp* and *counterscarp galleries.*

DIVERGENT RETREAT.—In marches in retreat, like those in advance, the same general rule holds of keeping to a single line, so as to have our fractions well in hand to oppose the greatest force possible to the enemy. Those retreats that are termed *divergent,* or *eccentric,* and which are made at the same time on divergent routes to deceive the enemy and render his pursuit uncertain, are extremely dangerous. In separating, to follow these divergent lines, we weaken ourselves on every point; the corps, being isolated, offer no mutual support; they are easily beaten, and, being forced upon any impassable obstacle, or surrounded, must be either annihilated or forced to surrender. The enemy, without allowing his attention to be drawn off from his object, will stick to one of these fractions until he has destroyed it, knowing that the others must fall an easy prey wherever they may be found, as from their dispersed condition they can offer no effectual resistance. Merely to keep them from reuniting will be enough for present purposes. There is but one case in which our forces can be dispersed with safety, and that is when we have just gained a decisive victory and are in the presence of an enemy who, having lost his communications, is entirely disorganized and demoralized. In this position of affairs we have only to throw our force into the midst of these broken-up fractions to determine them to fly. We may here attempt any blow; no movements can fail to turn out well except those which are too slow and methodical. This exception only becomes legitimate under the supposition that the disorganization and demoralization of the defeated army are complete.

DIVERSION.—In connection with marches as strategical movements, those operations performed by detachments, made to favor some design of the main body, and termed *diversions,* find a place. Diversions, and detachments made to aid the operations of the main body, when they have a long circuit to accomplish, are contrary to sound strategical principles.

In war, as in every other art based upon settled principles, there are exceptions to all general rules. It is in discerning these cases that the talent of the General is shown. Diversions belong to this class of exceptions. There are cases where they are not only called for, but are imperative upon the General. As, for example, when there is some position held by the enemy that must be carried before any other step can be taken, a diversion may be made either to threaten his line of communications, or to seize some commanding point near his position which, by forcing him to detach to meet the danger to him, will so weaken him as to allow us to make our main attack with good prospects of success. Cases of this kind are of frequent occurrence in mountainous positions, where, in order to force the enemy from some vantage-ground, a diversion on his flank or rear has to be made by a long circuit. Here the exception becomes the rule. Still, even in such cases care should be taken to call in the detachment as soon as the result is obtained, and fall back upon the rule of concentration and unity of operations. Besides, diversions are less dangerous in countries broken by forests and mountains, as the enemy finds it more difficult to throw himself between the main body and the detachment than in a country which has but few such obstructions and masks. In a mountainous region a small corps may find itself in a narrow valley, where it can neither be turned by its rear nor by its flanks, and where a large body would not find room to fight. In such cases the isolated corps need only be strong enough to defend themselves in front along the valleys they occupy. Here dissemination of our forces is only an apparent violation of the general principle; as, by falling back, each corps has still its line of retreat secure, and all can concentrate on some central point in rear of the mountain-passes. Another exception is found where our force is very superior to that of the enemy, and that we can better subsist our troops by separating them. Here we but follow a rule of Napoleon which he invariably put in practice; which is, *to disperse our force to subsist and to concentrate for battle*. However simple this rule may appear, none but an able General can carry it out successfully in practice; for it supposes a talent for military combinations possessed alone by Generals of this class. When our superiority in strength and *morale* is decidedly superior to that of our adversary, we may then resort to diversions to threaten his communications, to force him to abandon his fortified positions, to make raids into his territory, placing them under contribution, etc. All operations of this character, undertaken even under the most favorable circumstances, must be carried out with promptitude, vigor, and even audacity, to insure success. If made against a timid, irresolute Commander, the chances of their success are still further increased. But unless such favorable circumstances co-operate, it will be safer not to risk them.

DIVIDE.—In order to successfully travel the mountains it is necessary to understand their complete make-up and to know how to skillfully follow the *divides*. When a divide separates the waters of two streams not uniting with each other it is known as a *principal divide*, and always affords the best route of travel. The sides of cañons and ravines are frequently so precipitous that it is neither advisable nor possible to cross them; and although it is sometimes easy traveling along the bottoms (the level land inclosed between the sides), when not too narrow and rocky, the best route will, considering all things, be found along the divides. Such a route is frequently long and crooked, but it is a good one. Suppose it be required to pass from one stream to another parallel to it, but separated from it by very high and broken mountains. To accomplish this most expeditiously, follow up the first stream to a point where we will suppose a tributary of the stream puts in. Now if there be a good route, apparently, over the divide above this tributary, turn and follow it until the principal divide is reached. The route, if practicable, may be taken along the bottom, should water be desirable, as far as necessary. Having reached the principal divide, pass over it and descend by any suitable and practical divide leading from the principal divide to the other stream. It will be found that all the divides lead to the principal divide, and hence there will be no doubt as to finding the principal divide; but it will often require good judgment in selecting the most practicable divide leading to it. It will be still more difficult to select the practicable divide in descending, as all appear more or less practicable from the summit. The innumerable *cul-de-sacs* met with in descending can only be avoided by exercising great caution. In every case the divide selected should separate tributary ravines of two *important* tributaries of the stream. It is easily understood how these ravines frequently overlap each other and render the route very sinuous. It is recommended to follow game-trails, when discovered, in passing from one stream to another. They usually follow the most direct and practicable route over a fair divide. When arriving at the steep edge of a ridge, and where difficulty in finding a good trail is anticipated, it is a safe rule to descend first on foot and seek a trail for the command or train as you climb back again. It is much easier to make this selection while ascending than while descending; for when at the bottom of a hill its bluffs and precipices face you, so that they may be readily avoided, but when at the top of the hill these parts are overlooked and not seen until closely approached. The investigation of ravines is the exact reverse of that of the divides; but localities are much more readily lost when the ravines proceed thence in various directions. On crossing a divide and coming upon a system of ravines leading to a different *principal ravine*, the traveler should make very sure of his course and frequently take the bearings of the most prominent landmarks.

DIVIDING-ENGINE.—A machine for dividing a circle into a number of parts of equal proportions, either for the purpose of graduation, as the circles and arcs of astronomical, surveying, and plotting instruments, or for spacing off and cutting the circumference of a wheel into teeth. The dividing-engine was early applied to a mode of originating screws by Pappus Alexandrinus, a Greek mathematician of the fourth century. The methods of graduating instruments received much attention from Tompion (1660), Sharp (1689), and Bird (1745), the latter receiving 500 pounds from the Board of Longitude for his method of dividing. Numerous inventions and improvements in this line followed. The methods of *original graduation* are not practically adopted except for the largest and most important astronomical or geodetical instruments. Ordinary instruments are graduated by dividing-plates or engines which copy and adapt a set of already existing divisions. The dividing-plate which is used for common purposes, such as dividing compass-rings, etc., is a divided circle with a steel straight-edge made movable on the axis or arbor of the plate in such a manner that its edge during every part of its revolution shall fall in the exact line from center to circumference. The ring, protractor, or other instrument to be divided is clamped upon the plate with its center exactly coinciding with that of the plate, and the straight-edge is moved round and made to halt at the required divisions on the circumference of the dividing-plate, and by using the steel straight-edge as a guide corresponding divisions are marked off upon the concentric arc of the instrument to be divided. The *dividing-engine* is a very complex machine requiring the greatest accuracy and care in its construction; so much so that the possession of a good one affords the means of obtaining a very good income with a moderate amount of labor in using it.

Such was the case with the instrument of Mr. Parsons of London, who for many years divided a large proportion of the best theodolites, sextants, etc., that were made in Great Britain. Among the most celebrated dividing-engines may be mentioned those of Ramsden, Troughton, Simms, and Ross. A detailed account of the construction of these would far exceed our limits. Their principal parts consist of a large circle divided with extreme care by original graduation. This wheel is racked on its edge with teeth as equal and accurate as the divisions; a very carefully constructed endless screw works in these teeth, and is moved through any given number of revolutions, or any measured fraction of a revolution, by means of a treadle or other suitable power, thus making the requisite steps for each division; another part of the machine cutting a fine line at the moment of the halt of each step. These divisions are cut upon an arc of silver, gold, or platinum, which is soldered or inlaid upon the limb of the instrument, the precious metals being used on account of the oxidation to which common metals are liable. In 1843 Mr. Simms applied a self-acting apparatus to Troughton's circular dividing-engine, and an instrument of this manufacture may be seen at the Coast Survey Building, Capitol Hill, Washington. It has been somewhat modified, and is now driven by a small turbine in the stand. See *Graduation*.

DIVINE SERVICE.—In the United States army it is earnestly recommended to all officers and soldiers diligently to attend divine service. The Articles of War provide that any officer who behaves indecently or irreverently at any place of divine worship shall be brought before a General Court Martial, there to be publicly and severely reprimanded by the President thereof. Any soldier who so offends shall, for his first offense, forfeit one sixth of a dollar; for each further offense he shall forfeit a like sum, and shall be confined twenty-four hours. The money so forfeited shall be deducted from his next pay, and shall be applied by the Captain or Senior Officer of his troop, battery, or company to the use of the sick soldiers of the same.

DIVING-BELL.—A vessel inverted in water and let down to any depth by means of a rope, air occupying the upper part of the vessel. By means of the diving-bell men are able to descend to great depths, and to carry on such submarine operations as may be necessary in masonry, laying stones, and the like, and of keeping under water for some hours by the aid of fresh air supplied by pipes or barrels attached to the bell. The workmen accustomed to subaqueous existence do not suffer inconveniences; novices feel pains in the head and ears, but these pass away after a short initiation. It is stated that one man who had suffered from difficulty of breathing was completely cured by "belling," and that deafness is not produced by it, but, on the contrary, is in some cases relieved.

DIVING-DRESS.—In Schott's *Technica Curiosa*, published in 1664, is described a *lorica aquatica*, or aquatic armor, which consisted of a leathern dress, to protect the diver from the water, and a helmet. In 1721, Halley describes a contrivance of his own of nearly the same kind; its object was to enable the diver to go out from the bell and walk about; he was to be provided with a water-proof dress, and a small diving-bell, with glass front, as a helmet over his head, which was to be supplied with air by means of a tube from the diving-bell. The modern diving-dress is made of India-rubber cloth; a strong metal helmet, with round pieces of plate-glass in front, rests upon a pad on the shoulders; the air is supplied to this helmet from above, in the same manner as for the diving bell, but instead of the waste air passing out below, a second tube carries it up. Leaden weights are attached to the side of the diver, and thus he may descend a ladder and walk about below. He carries with him one end of a cord communicating with the assistants above, and by pulling this, as agreed upon, makes a series of signals.

DIVISION.—1. A section of an army, indefinite in point of numbers, but established as a matter of convenience. It often comprises infantry, cavalry, and artillery, and is in effect a small army in itself, commanded by a General Officer. In the Crimean War, for instance, a division comprised two brigades, each of three or four battalions.

The manner in which a division is posted varies with circumstances: it may be deployed in single line, with an interval of 100 yards between brigades for batteries, Fig. 1; two brigades may be deployed in the first line, the third in a second, Fig. 2; the three brigades may be deployed in two lines each, Fig. 3; or two brigades may be deployed in two lines, the third being held in reserve in line of masses, Fig. 4. The batteries are specially assigned by the General of Division to the most advantageous positions, an interval of 100 yards being allowed for each.

Fig. 1.

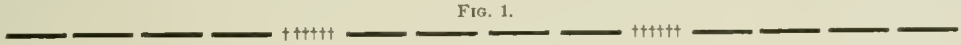


Fig. 2.

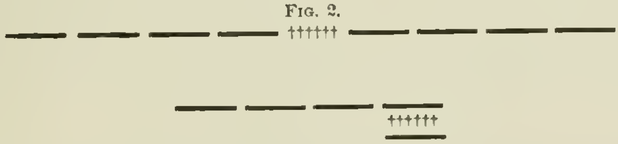


Fig. 3.

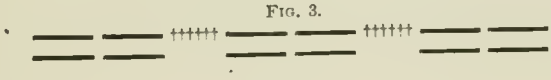


Fig. 4.

The commands of the General of Division are communicated through Staff-officers; they should be explicit, should be couched as far as possible in tactical language, and should be thoroughly comprehended by the officers delivering them. The batteries receive their orders through a Chief of Artillery, and conform in their movements to the tactics of the artillery arm.

The field-exercises of a division should be limited to those movements most practiced in active campaign, such as deploying into line from column of fours; advancing and retiring in line of battle; changes of front; change of front of one brigade; deployment of the reserve brigade on its right or left, and withdrawal of the third brigade into reserve; change of direction to the right or left by echelon from the left or right, and such other movements as occasion may require. Brigades in line are designated *right*, *center*, and *left*; or, if one be in rear, *right*, *left*, and *rear*; in column they are designated *leading*, *center*, and *rear*. In order that no mistakes may occur in transmitting orders, the names of the Brigade Commanders are always to be mentioned. In all successive formations, each brigade after completing the movement stacks arms and breaks ranks. The brigade is called to attention upon the receipt of the next command from the General.

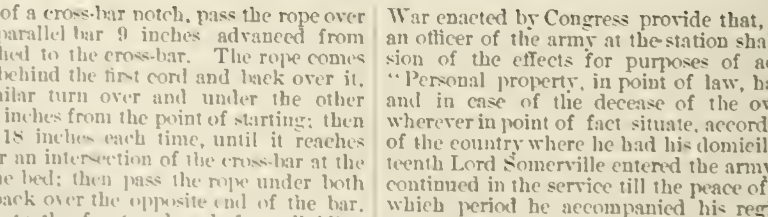
2. A Military Division is one of those larger portions into which a country is divided for convenience and to fix responsibility. The United States are at present divided into the following Military Divisions, viz.: 1. Division of the Missouri, comprehending the Departments of Missouri, Dakota, Texas, and the Platte; headquarters Chicago. 2. Division of the Pacific, including the Departments of California, Columbia, and Arizona; headquarters San Francisco. 3. Division of the Atlantic, including the Departments of the East and the South; headquarters New York.

DIVISIONAL ARTILLERY.—A portion of the field-artillery left to co-operate with the division of infantry or cavalry to which it is attached.

DIVISION COMMANDER.—The Commander of a Division, or of a geographical division of a country. He is assimilated to the Commander of a separate army, with the same powers and duties in similar cases over all the troops within the limits of his Department. See *Geographical Departments* and *Divisions*.

DIVISION-PLATE.—The disk or wheel in the gear-cutting lathe, which is pierced with various circular systems of holes; each circle represents the division of a circumference into a given number of parts.

DOANE LITTER.—A litter of poles and raw-hide, proposed by Lieutenant G. C. Doane, United States Army. The poles are 16 feet long, and the frame is so constructed as to give a bed 7 feet long, 3 feet 2 inches wide at one end and 3½ feet at the other. A lariat or raw-hide thong is used to cord the bed-space in the following manner: Tie one end at a corner over a lashing of a cross-bar notch, pass the rope over the opposite parallel bar 9 inches advanced from where it is lashed to the cross-bar. The rope comes under the bar behind the first cord and back over it, making a similar turn over and under the other parallel bar 18 inches from the point of starting; then back, gaining 18 inches each time, until it reaches and passes over an intersection of the cross-bar at the other end of the bed; then pass the rope under both parallels and back over the opposite end of the bar, and cord back to the front end as before, dividing each space of 18 inches, so that when finished the spaces will be 9 inches between bearings. The object of a second cording is to counterbalance the strain of the first, which would tend to throw one parallel forward and the other to the rear.



Doane Litter.

DOCK-YARD BATTALIONS.—Prior to the establishment of Volunteer Corps, Dock-yard Battalions formed a special element in the British military service, intended chiefly for the defense of the Royal Dock-yards. It was in 1847 that an item first appeared in the estimates of £20,000 for training and exercising about 9000 men in these battalions. Clerks, artisans, and laborers formed the body. The Colonel was a naval officer, and commissions were given to the other officers. The men received remuneration for time lost in drilling. A few hours per week in summer were set apart for drilling under the management of Sergeants and Corporals of Marines. At first the enlistment was voluntary, afterwards compulsory. These battalions were abolished in 1861.

DOG.—A clamp fastened to a piece suspended on the centers of a lathe, and by which the rotation of the chuck or face-plate is imparted to the piece to be turned. The chuck, known as the *dog and driver*, has two parts. The dog slips upon and is fastened by a set-screw to the object to be turned. The driver is attached to the lathe-mandrel, and has a projecting arm which comes in contact with the dog, and causes it and the work to revolve with the mandrel.

DOG-BOLT.—The bolt of the cap-square placed over the trunnion of a gun.

DOLABRA.—A rude ancient hatchet. Dolabras are represented on the columns of Trajan and Antoninus, and abound in all museums. When made of flint, which was their earliest and rudest form, they were usually called *celts*.

DOLPHINS.—Two handles formerly placed upon a piece of ordnance, with their centers over the center of gravity, by which it was mounted or dismounted.

DOMICILE.—By law every man's domicile is in the country where he has his permanent residence, or to which he ordinarily returns for the purpose of residence after occasional absence; and in case of his death, the right of succession to his goods and chattels and personal property of all sorts is regulated by the law of the country of his domicile, although he may happen to die beyond its limits. As regards military men, their employment on duty involving only temporary absence in intention would not, on common principles, cause a change of domicile; and as the laws of different States of the Union vary on the subject of the right of succession to property, the subject is of great interest to military men. An officer who was a native of South Carolina died intestate in the city of New York, and no heirs being forthcoming, his estate was taken possession of by the Public Administrator, although the Rules and Articles of War enacted by Congress provide that, in such cases, an officer of the army at the station shall take possession of the effects for purposes of administration. "Personal property, in point of law, has no locality, and in case of the decease of the owner must go wherever in point of fact situate, according to the law of the country where he had his domicile." The fourteenth Lord Somerville entered the army in 1745, and continued in the service till the peace of 1763, during which period he accompanied his regiment to England, Scotland, and Germany, both in quarters and on active duty. At his death, in 1796, a question arose whether, under the circumstances, his domicile was English or Scotch; and the Master of the Rolls (Sir R. P. Arden), in giving judgment, said: "I am clearly of opinion Lord Somerville was a Scotchman upon his birth, and continued so to the end of his days. He *never ceased* to be so, never having abandoned his Scotch domicile, or established another. The decree, therefore, must be that the succession to his personal estate ought to be regulated according to the law of Scotland." His Honor must consequently have been of opinion that, a Scotchman entering the British army does not thereby lose his original Scotch domicile; and since the union of England and Scotland, the army is certainly as much that of Scotland as of England. Sir Charles Douglas, a Scotchman by birth and original domicile, left his native country at the age of twelve, to enter the navy. From that time to his death he was in Scotland only four times: first, as Captain of a frigate; secondly, to introduce his wife to his friends, on which occasion he staid about a year; thirdly, upon a visit; and fourthly, when, upon his appointment to a command upon the Halifax Station, he went in the mail-coach to Scotland, and died there in 1789. He was not for a day resident there in any house of his own; nor was he ever there except for temporary occasions. He also commanded the Russian navy for about a year, and was afterwards in the Dutch service. He had no fixed residence in England till 1776, in which year he took a house at Gosport, where he lived as his home when on shore. This was his only residence in the British dominions; and when he went on service he left his wife and family at Gosport. At his death it became necessary to decide whether his domicile was Scotch or English, because he had made a will, bequeathing a legacy to his daughter, with certain conditions, which were void by the law of Scotland, but valid by the law of England. The House of Lords decided that his original domicile was Scotch, and that though he did not lose it in this first instance, by becoming an officer in the British navy, he abandoned it by entering a foreign service, and acquired a Russian domicile; that on returning to England, and resuming his position as a British officer, he acquired an English domicile, but did not recover his Scotch domicile; that his subsequent visits to Scotland, not being made *animo manendi*, did not revive his Scotch domicile, and that the succession to his property, as that of an Englishman, was therefore to be governed by the law of England, in which country he last acquired a domicile. In connection with this subject, it may be proper to notice an opinion expressed by the Master of the Rolls during the argument of Lord Somerville's case—that an officer entering the military or naval service of a foreign power, with consent of the British Government, and taking a qualified oath of allegiance to the *foreign* State, does not thereby abandon or lose his native domicile. In Forrest *v.* Funston, the defendant was a Lieutenant in the King's army, and held a situation of Master Gunner at Blackness Castle in Scotland, where he had the charge of considerable military stores, with an apartment for his residence. He was a native of Strabane in Ireland; and it was held by the Court of Session that, though it was his duty to reside at Blackness, he did not by the possession of his office acquire a Scotch domicile. With respect to the East India Company's Service, the question of domicile does not turn upon the simple fact of the party being under an obligation, by his commission, to serve in India; but when an officer accepts a commission or employment the duties of which necessarily require residence in India, and there is no stipulated period of service, and he proceeds to India accordingly, the law from such circumstances presumes an intention consistent with his duty, and holds his residence to be *animo et facto* in India. In the case of General Forbes, in the Court of Chancery, the subject of domicile in its relation to military men was extensively discussed before the Vice-Chancellor Wood. Nathaniel Forbes, afterwards General Forbes, was born in Scotland of Scotch parents; his father being possessed of an ancestral estate called Auchernach, on which there was then no house. In 1786, Nathaniel Forbes, being then a minor, and a Lieutenant on half-pay in the 102d Foot, a disbanded regiment, contracted a marriage with a Scotch lady. He shortly afterwards obtained an appointment in the service of the East India Company; and in December, 1787, he sailed for India, where he continued until 1808. He then obtained a furlough, and returned with his wife to Scotland. On the death of his father in 1794 he had succeeded to the family estate in Scotland; and during his furlough he built a house there, and furnished it, and made some improvements in the grounds. In 1812 he returned with his wife to India, and remained there for several years. The wife left India in 1818; and in 1822 her husband, who had then attained the rank of a General Officer and was Colonel of a regiment, also quitted India, according to the rules of the service, with the intention of never returning to that country; and he never did return thither. During the whole of his service under the East India Company General Forbes retained his commission and rank of a Lieutenant in the King's army. His domicile was without doubt originally Scottish. After his final return from India he had an establishment at a hired house in Sloane Street, London. He also kept his house at Auchernach furnished; and had some servants there also. He likewise became a Justice of the Peace and a Commissioner of Taxes in Scotland; and kept his pedigree and papers (including his will) at Auchernach, where he was in the habit of residing half the year, and where he had constructed a mausoleum in which he wished to be buried. But his health did not permit him to reside constantly at Auchernach, where his establishment was also not suitable for his wife; and his house in Sloane Street was manifestly his chief establishment, and his wife resided there. He died in 1851. His wife thereupon laid claim to a share of his property according to the Scotch law of succession, and contended that, in the events which had happened, he must be considered to have died possessed of his original Scottish domicile. The substantial question in the case was whether his domicile was in England or in Scotland. If he had been a single man, his final domicile would probably have been considered Scottish. But the Court held that Sloane Street, having been his chief establishment, and the abode of his wife, must be taken to have been the seat of his domicile. In pronouncing judgment upon the case, the learned Vice-Chancellor ruled the following points: 1. That the Scottish domicile of General Forbes, notwithstanding his having gone to India during his minority, in the service of the East India Company, continued until he attained the age of twenty-one: on the principle that a minor cannot change his domicile by his own act. 2. That on attaining twenty-one he acquired an Anglo-Indian domicile; and thereupon his Scottish domicile ceased: on the principle that a service in India, under a commission in the Indian army, of a person having no other residence, creates an Indian domicile. 3. That the circumstance of his being a Lieutenant on half-pay in a disbanded King's regiment did not affect the question. 4. That the Anglo-Indian domicile of General Forbes continued unchanged until his departure from India in 1822: the furlough, or limited leave of absence, implying by its nature that it was his duty to return to India on its expiration. 5. That in 1822 the Anglo-Indian domicile of General Forbes was abandoned and lost: the possibility of his being called upon, as Colonel of a regiment, to return at some indefinite time to active service in India being too remote to have any material bearing upon the question. 6. That he had acquired by choice a new domicile in England on his return from India.

DOMMAGE.—In a general acceptation of the term, *dommage* signified, in the old French service, the compensation which every Captain of a troop or company was obliged to make in consequence of any damage that his men might have done in a town or on a march.

DONATO ROSETTI SYSTEM OF FORTIFICATION.—This system has a large ravelin with flanks. Its double flanks are not retired. The shoulder-angle of each ravelin is connected by a fausse-braye. The shoulder-angles of the bastions and the flanks of the ravelin are joined by a wall destined to prevent desertion, and to enable the officers to go the rounds. This wall is destroyed towards the latter part of the siege, to enable the flanks to defend the ditch.

DONJON.—The principal tower or keep of a castle or fortress. It was so called either from being placed on a *dun* or elevation, natural or artificial, or because, from its position, it dominated or commanded the other parts of the fortress. From the circumstance that the lower or underground story of the donjon was used as a prison has come the modern meaning of the word. Also written *Dungeon*.

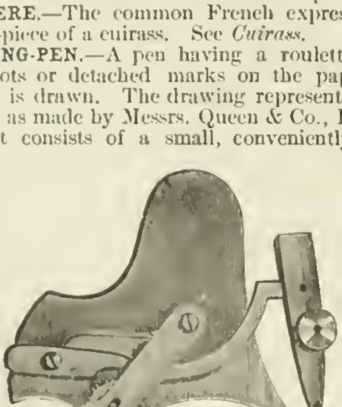
DOOLIE.—An Indian term: a stretcher for carrying the sick and wounded in India. It is composed of a framework of wood, and the seat or flooring of cane or nawar (a coarse cotton tape). At each end of the doolie a triangular piece of wood is fastened to the frame, on the top of which there is an iron ring attached through which the bamboo for lifting the doolie is placed. The top of the doolie has a light framework of wood, over which a coarse red cloth curtain is hung to screen the sun and wind from the patient. Sometimes written *Doolee*.

DORMANT.—In heraldic representation, an animal *dormant* has its head resting on its forepaws, whereas an animal *couchant* has its head erect. See *Heraldry*.

DOSSER.—A sort of basket carried on the shoulders of men, and used in carrying the earth from one part of a fortification to another where it is required.

DOSSIERE.—The common French expression for the back-piece of a cuirass. See *Cuirass*.

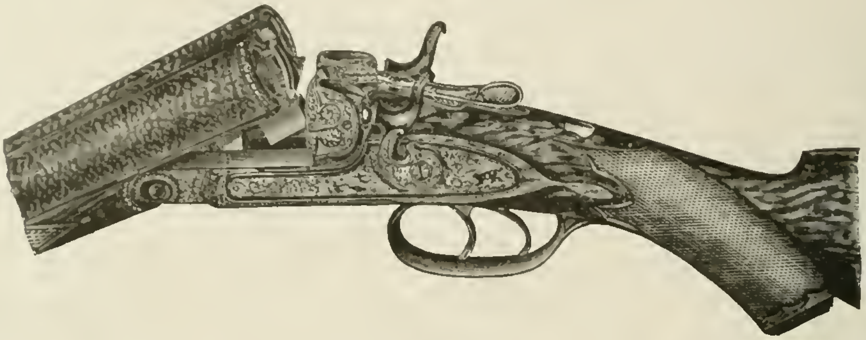
DOTTING-PEN.—A pen having a roulette which makes dots or detached marks on the paper over which it is drawn. The drawing represents the instrument as made by Messrs. Queen & Co., Philadelphia. It consists of a small, conveniently-shaped



German-silver plate, upon which is fastened a pen connected by a small bar and a ratchet movement with a rolling wheel. The bar is kept in its place by a small spring. Extra wheels of different patterns accompany the instrument, which, being readily changed, allow the making of various forms of lines. In using the instrument, care should be taken that the small point behind the pen rests on the paper, as it secures evenness in the stroke of the pen. See *Roulette*.

DOUBLE.—In tactics, to unite, as the ranks or files, so as to form one. *To double upon* is an expression meaning to inclose between two fires.

DOUBLE BARRELED GUN.—A gun having a pair of parallel barrels on the same stock; sometimes one is a rifle-barrel and the other a smooth-bore for shot. This combination breech-loading rifle and shot-gun is excellent for hunting purposes, and a single one judiciously handled will furnish a large command a good daily allowance of game in great variety. A few shot-guns should accompany every command in the field. The hunters should be selected with a view to the particular game sought after, as they seldom have the same success with all game. The barrels are usually placed side by side, as in the drawing; but some sportsmen prefer that one barrel be placed under the other.



Double-barreled Gun.

DOUBLE-BITTED AXE.—An ancient form of battle-axe, having two opposite bits or blades. It was a favorite weapon with the Franks in the time of Clotaire, seventh century, and with the Danes in the time of Alfred the Great, ninth century. It is also shown in the sculptures of Karnak, in Egypt. The battle-axe of the Scythians in the time of Herodotus was double-bitted. It is the Sacan *sagaris*. The double-bitted axe is found in the tumuli and barrows of North America. It is in three forms: 1, with a circumferential groove for the occupation of the withe or split handle to which it is lashed; 2, with an eye traversing the head; 3, with a socket for the handle.

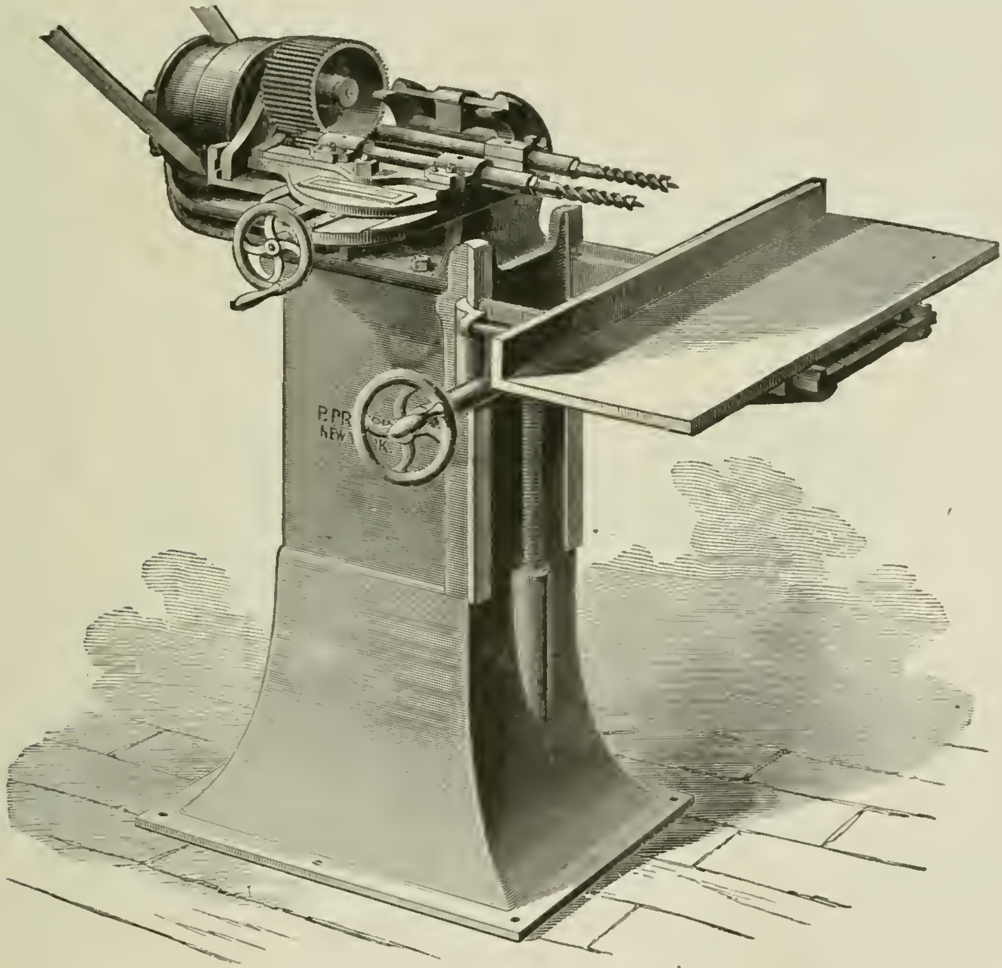
DOUBLE BORING AND MORTISING MACHINE.—A machine designed for that class of work in which two holes are to be bored at a given distance and angle, as in doweling, and in frame, carriage, and cabinet work. The two spindles are mounted on an adjustable head which enables them to be set to an angle from the horizontal, as shown in the drawing, to the vertical, where one would be over the other; and to any distance from one to five inches between centers. The table has a vertical movement of twelve inches from the spindle down, slides forward and back, and when prepared for mortising, sideways also. Adjustable stops determine the extent of these motions. Mortising is done with a revolving cutter cutting on both end and side, producing, when the work is moved sideways, a mortise with half-round ends. When only one spindle is to be used, it may be disconnected from the large gear-wheel by loosening and drawing back the bracket which supports the latter. This should be done whenever the machine is to be used for mortising, for then the belt may be run upon the small pulley and the spindle be driven at the high speed required, without injury to the gears. For boring, the belt should be run upon the large pulley, as so high a speed is not necessary for boring as for mortising. The spindles and their pinions are of steel, and the bearings are adjustable. The weight of the machine as used in the arsenal is about 500 pounds, and the speed of the countershaft, 950 to 1000 revolutions per minute. See *Boring-machine* and *Mortising-machine.*

DOUBLE BRIDGE-HEAD.—When the bridge crosses the river at a point where there is no bend, it is frequently the case that works are constructed at both extremities of the bridge. When this is the case, the works form what is known as a *double bridge-head*, to distinguish it from those usually termed single bridge-heads. See *Bridge-head.*

DOUBLE CAPONIERE.—A structure, in permanent fortification, which serves both as a communication and as a defensive work for the ditch. As the former, the passage should admit of a convenient circulation, without being too wide, which has determined its width at 3.30 yards. The interior crests should cover the troops within the caponiere from the enemy's establishments on the crest of the bastion covered-way; a relief of nine feet has been found sufficient for this purpose. As a defensive work, its fire should sweep the ditch. It is for this purpose that its embankments are arranged on the interior as an ordinary parapet, and on the exterior in the form of a glacis. Its banquette tread is made 2 yards wide, as it should be palisaded. In order that the embankment of the caponiere may not, by its relief, form dead spaces in the ditch, the plane of the first glacis is arranged so as to be swept by the artillery-fire of the opposite flank. The plane of the second glacis, and the return-wall, are so arranged as to be swept by the fire of the curtain, and of a part of the flank. The portion of the first glacis near the extremity is made into a *glacis-coupé*, leaving a sufficient thickness of parapet to cover the passage. See *Noizet System of Fortification.*

DOUBLE HAMMER.—A forging device for operating upon a bloom or puddler's ball, striking it upon opposite sides simultaneously.

DOUBLE HARQUEBUSE.—A firearm with a double catch or match-holder. It was mostly used for defending ramparts; the length being from three to seven feet. The lock is distinguished from that of the simple harquebuse in having two match-holders working in opposite directions. It was often supported by a stand resting on iron spikes or wheels that was called *fourquine.*



Double Boring and Mortising-machine.

DOUBLE-HEADED SHOT.—A projectile formerly in use, consisting of two shot united at their bases.

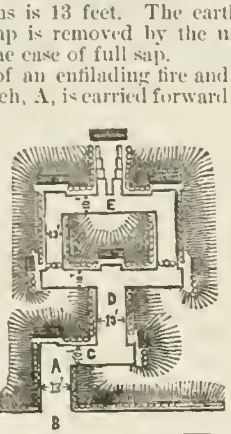
DOUBLE-QUICK.—Performed in the time called *double-quick;* a double-quick step or march as prescribed in Tactics. See *Step.*

DOUBLE RANK.—A line formed of double files. In the United States army, the distance between ranks, from back to breast, is *facing distance:* but on rough ground, and when marching in double time, it is increased to thirty-two inches; upon halting, the rear rank closes to facing distance. When the knapsack is worn, the distance between the ranks is increased by the depth of the knapsack. In alignments in double rank, the rear-rank men cast their eyes to the side of the guide with the front-rank men, and maintain the proper distance between the ranks. The double rank, faced by the flank, is called a *column of files*, the same as a single rank. In marching in column of files, each rear-rank man dresses on his front-rank man, who is the guide of the file. In obliquing in line in double rank, each rear-rank man follows the man next on the right or left, or the second man on the right or left, of his front-rank man, according as the rear-rank is at facing distance, or at thirty-two inches from the front rank. In obliquing in column of files, the guide of each file is the man of the rank toward which the oblique is made, the guide of the column being the guide of the leading file.

DOUBLE REDAN.—Two redans are sometimes placed side by side and joined to each other, making a work known as the *double redan;* sometimes the outer faces of the double redan are made much longer than the faces which are connected, in which case the work receives the name of *priest-cap* or *swallow-tail.*

DOUBLE SAP.—This sap consists of two heads of sap pushed forward by two brigades working abreast. Its object is to form a trench in a position exposed to fire in front and on both sides. The head of the sap is covered by two sap-rollers placed end to end; a bag of wool, or a short sap-roller, being placed at their junction, for a screen. The distance between the two rows of gabions is 13 feet. The earth between the two lines of sap is removed by the usual working-parties, as in the case of full sap.

In the case of an enfilading fire and a fire on both flanks, the trench, A, is carried forward by the double



Plan of a Double Sap exposed to a fire in front and on both flanks. A, D, Double Direct Sap; B, Parallel; C, Full Sap at right angles to gain the direction D; E, Full Sap connecting the two branches of double direct sap on the right and left.

sap, until the point of departure, B, is about being exposed to the fire coming in over the sap-rollers; a change of direction, C, at right angles is then made by the full sap, to the right or left, and pushed forward the length of about fifteen gabions, or so far as to intercept any slant fire on either side of the trench in rear, when the original direction, D, is resumed by the double sap. A change of direction is sometimes made by the full sap both to the right and left at right angles to the original line, and pushed to the length of twelve or fourteen gabions each way. Then, from the extremities of these branches, a direction parallel to the original is taken up by the double sap, and pushed on until the point of departure to the rear is about being exposed, when a change of direction towards each other is made at right angles, by the full sap, and two branches are united on the original direction, E, which is resumed by the double sap. See *Sap.*

DOUBLE SHELL.—This nature of projectile has been introduced into the English service for the use of certain R.M.L. guns, such as the 7-inch and 7-pdr. M.T. gun, but for no other, though very good practice has been made with these shells from the 16-pdr. field-battery gun. The 7-inch double shell is nearly four calibers long, strengthened by three ribs internally, otherwise resembling the common shell. A bag is used to contain the bursting-charge as given for common shell. See *Double-shotting.*

DOUBLE-SHOTTING.—A term applied to the doubling of the shot in the gun, whereby increased effect is expected. This was formerly a practice more often adopted in the navy than in land-artillery. In the latter, double-shotting was only resorted to when, the enemy being close on the guns, a double charge of case-shot was likely to render good service. The introduction of rifled guns has done away with this mode of fire. What is now known as a "double shell" is nothing more than a shell of increased length and capacity.

DOUBLET.—An under-garment of linen, slightly quilted, and having rings of mail under the breast-plate and under the knees and arms, so as to protect the body where the armor was weakest, and wherever an opening might occur for the sword or poniard. It was almost identical with the jerkin. The sleeves were sometimes separate, and tied on at the arm.

DOUBLE TIME.—The fastest time or step in marching, next to the run, requiring 165 steps, each 33 inches in length, to be taken in one minute. The degree of swiftness may vary in urgent cases, and the number of steps be thus increased up to 180 per minute. See *Double-quick.*

DOUBLINGS.—The heraldic term for the linings of robes or mantles, or of the mantlings of achievements. See *Mantling.*

DOVER IRON.—Previous to casting the gun-casing of the 12.25-inch muzzle-loading rifle of the South Boston Foundry, a number of experimental castings were made and tested with a view to determine the proper quality of iron to be employed. This course was necessary in order to provide a substitute for the Richmond pig-iron, which can no longer be procured of suitable quality for gun construction. The most satisfactory results in these experiments were obtained from a mixture of equal quantities of Dover and Muirkirk pig-iron. A trial-cylinder, of the same form and dimensions as those described in Captain Rodman's *Experiments on Metals for Cannon*, was then cast from the mixture. This cylinder was cut up in the same manner as those above referred to, and was subjected to a similar series of tests for the purpose of determining the physical properties of the metal. The results obtained from these tests were satisfactory, and it was decided to use a similar mixture for the gun-casing. The Dover is made at Chatham, Columbia County, New York, being smelted with charcoal from a brown hematite ore found a few miles south of Dover Plains, Dutchess County, New York. This ore is mined in a wide vein, and is of two kinds, there being two lines of deposit in the stratum. One is a rich, solid ore, yielding from 48 to 55 per cent of iron; the other yields from 38 to 42 per cent. In smelting the iron the two kinds of ore are used in nearly equal proportions, it having been found that such a mixture gave the best results. See *Iron* and *Muirkirk Iron.*

DOWLAS.—A coarse kind of linen; it is used in a saltpeter-refinery for filtering the saltpeter liquid as it is drawn off from the boilers.

DRABANTS.—A choice company of 200 picked men, of which Charles IX. of Sweden was Captain.

DRAFT.—A selecting or detaching of soldiers from an army, or any part of it, or from a military post; also from any company or collection of persons, or from the people at large for military service. Also written *Draught.*

DRAG.—A mechanism for slackening the speed of carriages, by operating on one or more of the wheels. The form of drag best known is that of the "shoe," a hollow piece of iron attached by a chain to the carriage, which being put below one of the hind wheels partially reduces the vehicle to the quality of a sledge; by which dragging process the carriage is suitably retarded on going down-hill. As the shoe-drag required to be applied and removed with some inconvenient detention of the vehicle, a step was made in advance when a method of retarding a wheel without detention was discovered. This new process, which is known as the patent drag, consists of a connected piece of mechanism, altogether operated upon by the driver without moving from his seat. A handle affects a series of rods and levers by which a species of shoe is pressed against one of the wheels, so as to slacken its motion. Such is the kind of drag now very generally attached to gentlemen's traveling-carriages, omnibuses, and other vehicles for passengers on the roads much traveled. It is of French origin. Applied in either form, the use of the drag, independently of its safety, is to allow horses to continue running at ordinary speed down-hill without being unduly pressed on by the carriage behind them. A similar contrivance, but of a more powerful kind, called a *break* or *brake*, is applied to arrest the motion of railway-trains. See *Brake.*

DRAGON.—A small kind of blunderbuss; a short hand-gun of great bore to carry several pistol or carbine balls or small slugs, and so called from the fact of its having a dragon's head at the muzzle.

DRAGON ET DRAGON VOLANT.—The ancient title for two old pieces of artillery. The dragon was a 40-pounder; the dragon volant, a 32-pounder. But neither the name nor the size of the caliber of either piece is now in use.

DRAGONNER.—According to the French acceptation of the term, to attack any person in a rude and violent manner; to take anything by force; to adopt prompt and vigorous means; and to bring those people to reason by hard blows who could not be persuaded by fair words.

DRAGON'S-BLOOD.—A deep red resinous substance found in the East Indies, Cochin-China, and the Eastern islands. It occurs in masses of various degrees of purity, and in sticks, enveloped in palm-leaves. Dragon's-blood is employed as a coloring matter, and as an ingredient in varnishes. Formerly it was used in the browning liquid for gun-barrels, but has been discontinued for some years past.

DRAGOON.—From the old fable that the dragon spouts fire, the head of the monster was worked upon the muzzles of a peculiar kind of short muskets which were first carried by the horsemen raised by Marshal Brissac in the year 1600. This circumstance led to their being called dragoons; and from the general adoption of the same weapon, though without the emblem in question, the term gradually extended itself till it became almost synonymous with horse-soldier. Dragoons were at one time a kind of mounted infantry, drilled to perform the services both of horse and foot. At present, *dragoon* is simply one among many designations for cavalry, not very precise in its application. In the British army, the *heavy* dragoons and the *light* dragoons are carefully distinguished in regard to the weight of the men, horses, and appointments. The first dragoons in the army were the Scots Greys, established in 1683. The dragoon, when first instituted to combine the functions both of the foot soldier and cavalier, was found, like most mongrels, to have the qualities of neither in a very serviceable degree. He still retains his musquetoon, and on outpost duty, and skirmishing in broken ground, does a soldier's duty with this weapon. Apt for attacks, whether in close order or dispersed, he should lend himself to the charge kindly; and in cases where thrown on his own resources, display all the intelligence, activity, and circumspection of the best light infantry. See *Cavalry* and *Horse-guards.*

DRAGOON GUARDS.—A title borne by seven regiments of heavy cavalry in the British service.

DRAG-ROPE.—A rope having a small chain and hook attached to one end of it; it is used in the artillery service for pulling or drawing. Drag-ropes are attached to all ordnance-carriages, to assist in extricating them when in difficulty, in sandy soil, steep ascents, or in descents when there is no shoe attached to the carriage, or locking-chain for holding upon the carriage. They are of two sizes in the English service, *heavy* and *light;* the former are issued to the 20-pdr., 40-pdr. B.L.R., and 16-pdr. M.L.R. batteries; the latter to the 9-pdr., 12-pdr. B.L.R., and 9-pdr. M.L.R. batteries. The chain end is intended to prevent the rope being cut by the tire of the wheel.

DRAG-ROPE KNOT.—A knot the same as the *men's harness-hitch;* it is used for fixing handspikes to the ropes attached to heavy carriages which are to be moved by men; three men are attached to each handspike. Sometimes called *lever-hitch.*

DRAG-ROPE MEN.—The men attached to light or heavy ordnance, for the purpose of expediting movements in action. The French *Servans à la prolonge* are of this description.

DRAG-WASHER.—A flat iron ring on the axle-arm of a carriage, having an iron loop attached for the purpose of fastening the drag-rope when necessary; hence the term *drag washer.* It is placed on the axle-arm to prevent the wheel or nave from pressing upon the linch-pin.

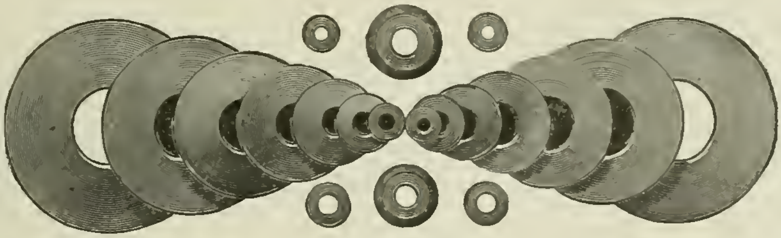


Plate-washers of the pattern represented in the drawing are usually made in large quantities at the arsenals. The following table exhibits their particulars:

Diameter.	Size of Hole.	Thickness Wire Gauge.	Size of Bolt.	Number in 100 Pounds.
1/2	1/4	No. 18	3/16	45,000
5/8	5/16	" 16	1/4	21,000
3/4	5/16	" 16	1/4	13,900
7/8	3/8	" 16	5/16	11,250
1	7/16	" 14	3/8	6,800
1 1/8	1/2	" 14	7/16	5,450
1 1/4	1/2	" 14	7/16	4,300
1 3/8	9/16	" 12	1/2	2,600
1 1/2	9/16	" 12	1/2	2,000
1 1/2	5/8	" 12	9/16	2,250
1 3/4	11/16	" 10	5/8	1,310
2	13/16	" 10	3/4	1,010
2 1/4	13/16	" 9	7/8	860
2 1/2	1 1/16	" 9	1	625
2 3/4	1 1/4	" 9	1 1/8	520
3	1 3/8	" 9	1 1/4	400
3 1/2	1 1/2	" 8	1 3/8	280
3 3/4	1 5/8	" 8	1 1/2	240
4	1 7/8	" 8	1 3/4	220
4 1/2	2 1/8	" 8	2	175

DRAIN.—In the military art, a trench provided to draw water out of a ditch, which is afterwards filled with hurdles and earth, or with fascines or bundles of rushes, and planks to facilitate the passage over the mud. Also written *Drein.*

DRAKE.—A small piece of artillery used in ancient times, but now obsolete.

DRAUGHT-ANIMALS.—The subject of draught is of the greatest importance in the artillery arm of the service, in which the greater portion of the transport of artillery *matériel* is dependent on draught-animals. Horses are usually employed for this purpose, though in India the heavy artillery, with the rest of the *matériel* of the army, is drawn or carried by elephants and bullocks.

In a four-footed animal, the hinder feet are the fulcrum of the lever by which its weight acts against the load; and when the animal pulls hard it depresses its chest, and thus increases the lever; hence we see the benefit that may be derived from large horses, for their levers necessarily increase with their sizes. Large horses will draw more than small ones, even though they have less muscular force and are unable to carry such a heavy burden.

The force exerted by a draught-animal may be divided into two parts, viz., that which overcomes the inertia and friction of the carriage and sets it in motion, and that which is necessary to overcome the resistances which recur along its path. The first, being of momentary duration, approximates the utmost strength of the animal; its intensity should be known in order to give the necessary strength to the harness.

If Q represents the mean force (in pounds) exerted by an animal, in a unit of time, in drawing a load over a road, the length of which is l, Ql represents the quantity of work performed. The direction of the force is taken parallel to the plane along which the load moves. If it make an angle, a, with this plane, the work will be decomposed into two components, $Ql \cos a$, which is parallel to the plane, and $Ql \sin a$, which is perpendicular to it: the latter transfers a portion of the load from the ground to the animal's shoulders, thereby increasing his friction, and to a certain extent the power of traction.

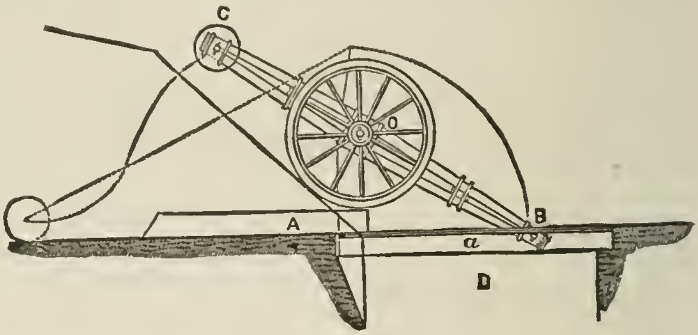
Careful experiments have been made to determine the proportion of those two components most favorable to the exercise of the animal's power. It was found that the most suitable angle for the traces of an unloaded animal, with the ground, was from 10° to 12°; and for one that carried his driver, from 6° to 7°; or, in other words, a draught-animal should *carry* ⅛ of his load on his back.

The relation between the weight of a loaded carriage and the force to be expended by the animal to keep it in motion depends upon so many circumstances that it is impossible to give a general expression for its determination. It can only be determined by direct experiment in each particular case. See *Artillery-horses*, *Bullock*, *Elephant*, and *Mule*.

DRAUGHT-HOOK.—Either of four large hooks of iron fixed on the cheeks of a gun-carriage, two on each side, used in drawing the gun backward and forward.

DRAW-BORING.—The operation of polishing a musket-barrel after it has been rifled.

DRAW-BRIDGE.—For the usually narrow ditches of field-works either a light rolling bridge may be used for a communication, from the outlet, across the ditch, or else an ordinary wooden draw-dridge. A very simple one, and of easy construction, was proposed by Colonel Bergère of the French Engineers. The bridge is a light platform, a, of joists and boards, long enough to span the ditch, D, and so arranged as to turn around an axle at A, the crest of the scarp. At the point B on each side of the platform an iron gudgeon is firmly attached to it, and turns in the eye of a socket at the end of the lever, C B. This lever is formed of two pieces of scantling of some tough flexible wood, each about four inches square. The lever has an eye at the middle point, O, which receives a strong iron bolt that connects two ordinary gun-carriage wheels. The two pieces which form the lever are firmly fastened together, as shown in the figure; a weight, consisting of shells filled with sand or shot, being fastened at the end C and serving as a counterpoise to the bridge. Two rails, A, of heavy scantling are laid for the wheels to run upon in maneuvering the bridge, which is done simply by one or two men taking hold of the spokes of the wheels, and so, by turning them, causing them to run backwards or forwards, and thus raise or lower the bridge. The outlet should be covered by a mask thrown up either on the interior or on the exterior, to prevent the enemy from firing through it into the work. A traverse is thrown across it if placed on the interior. When placed on the exterior a small redan is constructed, just in advance of the counterscarp, of sufficient size to cover the outlet and the bridge over the ditch. The

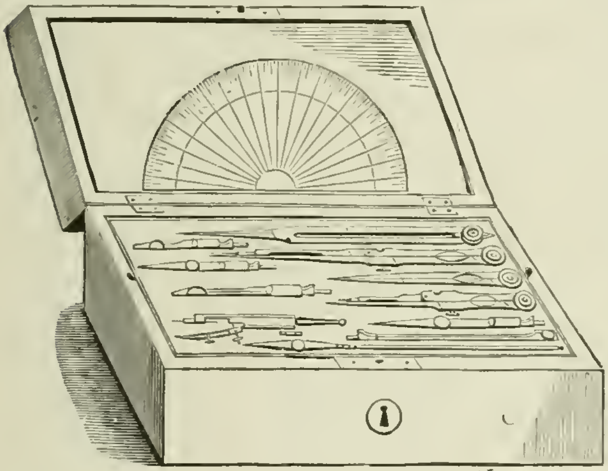


Bergère Draw-bridge.

passage to the exterior may be either through the face of the redan or between one of the faces and the ditch. Sufficient space should be left between the traverse and the parapet for the passage of a gun. The length of the traverse is arranged to prevent the enemy from firing into the work, by an oblique fire through the outlet. The traverse may be of earth or of wood; in either case it should be arranged for defense to enfilade the outlet. In some cases the traverse at one end is broken forward at right angles, and connected with the parapet of the work; the space between the traverse and parapet at the other end being left open for a passage-way. A defensive stockade with a barrier secures this opening from surprise. It should be thrown far enough back to be out of reach of fire.

DRAWING.—1. The operation of hammering, rolling, or drawing through a die, by which a bar or rod of metal or a wire is extended in length to form a rod, tube, or plate. 2. The art of representing the appearances of all kinds of objects by imitation or copying, both with and without the assistance of mathematical rules. The following instruments, necessary for drawing and plotting in the field, should be carefully packed in portable boxes or pocket-cases, and supplied to all Staff and Reconnoitering Officers: one pair of 6-inch needle-point dividers, with pen and pencil points and lengthening-bar; one pair of 4½-inch plain dividers; one pair of 3½-inch needle-point dividers, with pen and pencil points; one spring bow-pen, with needle-point; one drawing-pen; one German-silver protractor; one horn protractor; one irregular curve; two wooden triangles; and one pair of proportional dividers.

The first requisite in all drawings is *minute accuracy*, both in the geometrical constructions and in writing down all letters and numbers which serve either as references or to give dimensions. To attain this, so far as regards the geometrical part, judgment is to be exercised in the selection of the means for establishing on the drawing the positions of the various points which are either given or to be found; as one method, although in theory as correct as some other, may not, in practice, be found to yield as satisfactory results. The following remarks will serve to illustrate this point: 1st. *In setting off from a scale of equal parts* *several distances, along a line*, whether equal or unequal, the most accurate method is to commence by first setting off the entire distance, and then the several parts, taking care to verify, from the scale, the aggregate of the several partial distances. 2d. *When a distance to be set off is so small* that it cannot be laid down with accuracy by the points of the dividers, the following method may be employed: Set back, from the point from which the required distance is to be set off, any arbitrary distance, then set forward, from this last point, a distance equal to the sum of this arbitrary distance and the one required. 3. *To set off a point at a given perpendicular distance from a line*, it will mostly be found more speedy, and more accurate, to take off from the scale the given distance, in the dividers, and, setting one point on the paper, bring the other so that the arc described by it, with the given distance as a radius, shall be tangent to the line, than to employ the usual method of first erecting a perpendicular to the line and then setting off the required point along the perpendicular. This method will be found convenient in drawing a parallel to a line at a given distance from it by setting off another point in the same way, and drawing through the two the required parallel. 4th. In setting off several points for the purpose of *drawing several parallels to a given line*,



Drawing Instruments.

as, for example, the parallel lines which bound the planes of a parapet, it will be found most speedy and accurate to draw first upon a slip of smooth thin paper two lines perpendicular to each other, then marking on one of the lines the respective given distances of the parallels from the other, and cutting the paper close to the line along which the given points are marked off, so that when the strip is laid upon the drawing so as to have one of its lines to coincide with that to which the parallels are to be drawn, their distances from it can be pricked off by a sharp pointed pencil, or in any other way. 5th. *When a point is to be constructed by means of the intersection of two lines arbitrarily chosen*, such a position should be assumed for the arbitrary lines that they shall not form a very acute angle at their point of intersection, as in that case this point might not be so distinct to the eye as to be marked with accuracy. For example, in erecting a perpendicular to a line at a given point, and in like problems, in which points are found by the intersections of arcs of circles, it will be best and most convenient to take for the radii of the arcs the distance between their centers, as the angle between the tangents to the arcs at their point of intersection will then be 60°, which is a sufficient angle to give accurately the point where the lines cross. In all such cases of determining points, and where a point is pricked into the paper, it will be found advisable to *designate the point thus* ⊙, by a small circle drawn around it with the lead-pencil, in order that the eye may see it with more distinctness. 6th. *In determining a portion of a line by the construction of two arbitrary points*, the points should be so chosen that the portion required may fall between them and not beyond them. 7th. No means of verifying the accuracy of the construction of points or lines should be omitted. A general and minute verification of all the parts of the drawing should be made before any portion of it is put in ink. Neatness is a not unimportant element in the attainment of accuracy in drawing. A few minutiæ, when attended to, will subserve this end. That part of the paper on which the draughtsman is not working should be kept covered with clean paper, pasted on the edge of the board, so as to fold over the drawing, and the parts which are finished should be similarly protected. Before commencing the daily work the paper should be carefully dusted, and the scales, rules, and triangles be carefully wiped with a clean dry rag. As few lines of construction as possible should be drawn in pencil, and only that part of each which may be strictly necessary to determine the point sought. As, for example, where a point is to be found by the intersection of two arcs of circles; when the position of the point can be approximately judged of by the eye, only a portion of one arc, which will embrace the point, may be drawn, and the point where the second arc would intersect the first be marked without describing the arc. No more of any line of the drawing should be made in pencil than is to remain permanently in ink. The object of these precautions is to keep the paper from becoming covered with dirt and the lines from being defaced by the wear of the paper. In *inking* the lines the following directions will be found useful: Efface carefully all pencil-lines that are not to be inked, and those parts of the permanent lines which are not to remain, before commencing to ink. When right lines are tangent to curves, put in ink the curve before the right line; draw all arcs of equal radii at once, one after the other; if several arcs are to be described from the same center, it will be well to put a thin bit of quill over the point for the end of the dividers to rest on, to avoid making a large hole in the drawing. If the drawing is not to be colored with the brush, all the lines of one color should be put in before commencing on those of another. If one of the bounding lines of a surface is to be made heavier than the others, its breadth should be taken from the surface they limit and not be added to it; and when the heavy line forms the boundary of two surfaces, its breadth must be taken from the one of greatest declivity. When the drawing is to be *colored*, all lines that are not to be black may be put in first with black, making them very faint, so that they may receive their appropriate colors after the drawing is otherwise completed. No heavy lines should be put in until the work with the brush is completed. When all the lines are in, the drawing should be thoroughly cleaned with stale bread-crumbs, and then have several pitchers of water dashed over it, the board being placed in an inclined position to allow the water, colored by the ink-lines, to escape rapidly and not to discolor the paper. In using the brush, whether for flat tints or graded, the requisite depth of tint should be reached by a number of faint tints laid over each other; this is especially necessary in laying tints of blacks, browns, and reds. To obtain an even flat or graded tint on dry paper requires considerable skill. The best plan for this is first to wet with a large brush or clean rag the surface on which the tint is to be laid, then with a slightly moist rag clear the surface of water, and before the paper has time to dry to lay on the tint. With this precaution, the heaviest tints of Chinese ink, the most difficult of all to manage on dry paper, can be neatly laid down.

The *lettering* and *numbering* of a drawing should be in ordinary printed character; this is particularly requisite in the numbering, to avoid misapprehensions which often arise from individual peculiarities in writing numbers. As has been already remarked, references are written in black, within brackets which, when practicable, embrace the point referred to. When not practicable, a small dotted line may lead from the point to the reference; thus, ⨀...(25.50); but to distinguish references from other numbers the designation of the unit is omitted. All horizontal distances between points are written upon a dotted line drawn between the points, with an arrow-head at each end; where several partial distances in a right line are marked, it will be also well to mark the total distance: the latter may be written above or beneath the former. In writing horizontal distances, the usual designation of the unit is always written thus: *y* for yards, ′ for feet, etc. All the numbers must be expressed in the same unit, the fractional parts being in decimals. References and horizontal distances cannot be too much multiplied, in order to avoid misapprehensions, and the results of errors of construction, as well as to save the time that would be taken in applying dividers to the drawing to find from the scale affixed to it the dimensions of any part. A *scale* very accurately constructed should be affixed to the drawing before it is cut from the board, so that the shrinkage of the paper, which is about $\frac{1}{500}$, may affect all the parts equally, and the scale thus be made to correspond to the real lengths of the lines on the drawing. The scale should be divided according to the decimal system, as being most convenient for counting off. The first division of the scale should furnish the units, and also their decimal parts if the scale bears that proportion to the true dimensions of the object represented which will admit of these divisions. This first division is numbered from right to left, the zero-point being on the right, the 10-point on the left; the succeeding divisions, to 50 inclusive, should each be equal to the first division, containing ten units each. The remaining divisions may contain fifty units each. It will be seen that any number of tens, units, or fractional parts of a unit can thus be readily taken off from the scale by the dividers. The scale should be long enough to give the dimensions of the longest line on the drawing. The proportion which the scale bears to the true dimensions of the object should be written above the scale; thus, *scale one inch to ten yards, or* $\frac{1}{360}$. And the designation of the unit of the drawing should be annexed to the last division on the scale, as *yds.* for yards, *ft.* for feet, etc.

DRAWING AND QUARTERING.—In Great Britain the punishment for treason still is that the offender be *drawn* to the place of execution on a hurdle; that he be hanged by the neck till he be dead; that his head be severed from his body, and that his body be divided into four parts, or *quartered.* The Sovereign may, and now certainly would, by a warrant under the Sign-manual, countersigned by a principal Secretary of State, change the sentence into beheading. In the case of females the quartering is dispensed with.

DRAWING-BOARD.—A board on which drawing-paper is strained for painting on in water-colors. The paper is wetted for the purpose of being strained, and when attached at the edges it is permitted to dry and contract. Formerly the drawing-board was fitted into a frame, the edges of the wet paper being made fast by the pressure of the frame on the board. But the much simpler drawing-board which is now in use is made of a flat piece or pieces of wood, held together and prevented from warping by an edging of other pieces, the grain of which runs in the opposite direction. The wet paper is attached to the edges of the board with paste or thin glue, and when dry becomes perfectly firm and flat. When the work is finished, the paper is cut beyond the drawing with a knife.

DRAWN BATTLE.—A fight from which the combatants withdraw without either side claiming the victory.

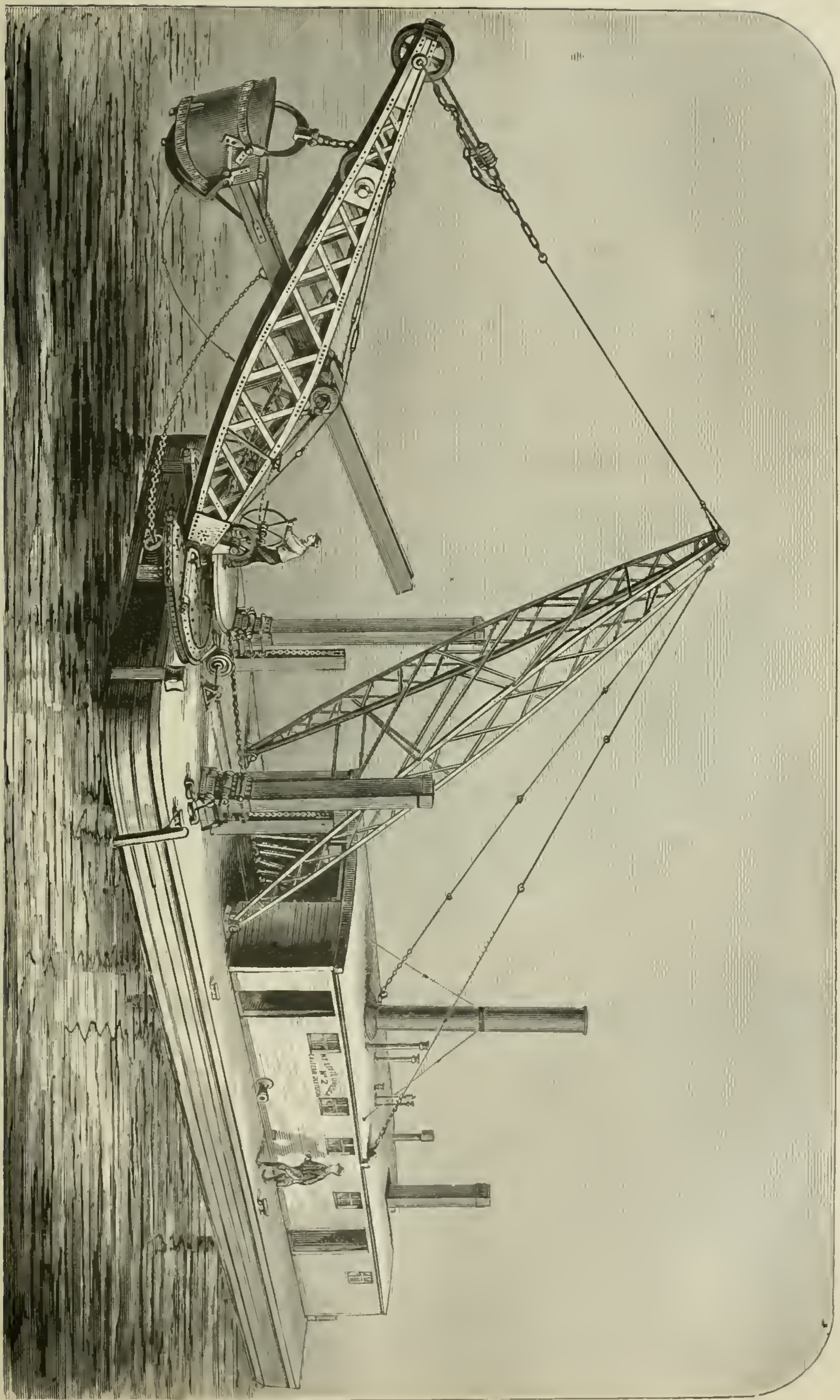
DRAW-PLATE.—A steel plate with a graduated series of holes, through which metals are drawn in making them into wires or bars. Also a name given to a plate of metal placed before a fire or before the lateral opening between the top of the fireplace and the throat of the chimney. Its use is to force the air to pass through the fire on its way into the chimney, instead of allowing it to pass over the fire.

DREDGING-BOX.—To render the fuses of mortar-shells more certain of taking fire, meal-powder is sprinkled over them, after the shell is placed in the mortar, from a *dredging-box.* It is made of sheet-copper. The top fits over the box, and is pierced with holes for the escape of the powder.

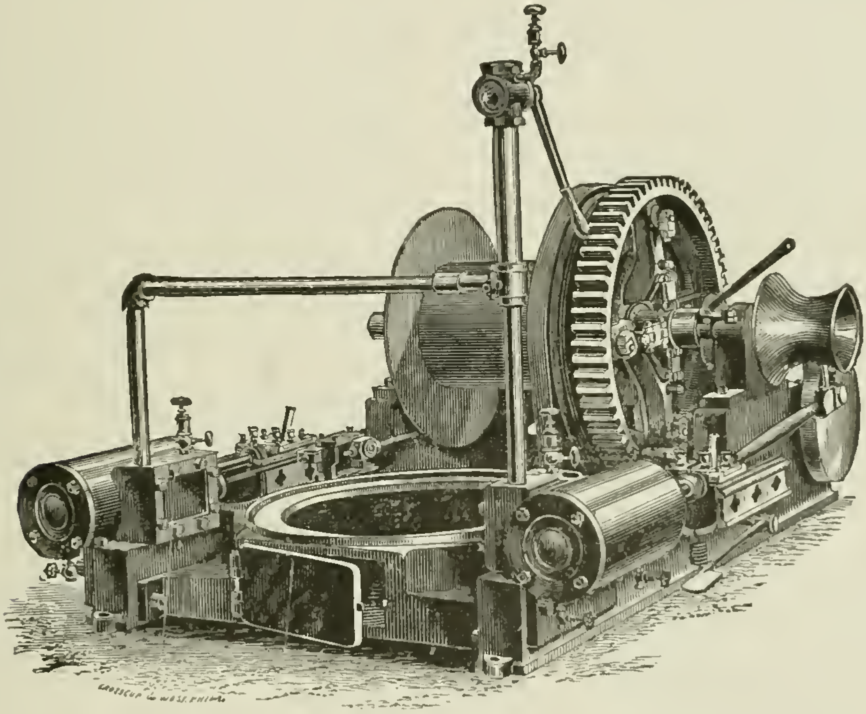
DREDGING-MACHINE.—A machine designed for clearing out or deepening the channels of rivers, harbors, etc. The bucket dredging-machine is very efficient and is much used for the lighter grades of work. It consists of a long stage or framework overhanging the side of the barge. This frame has a wheel at each end, upon which works a powerful endless chain, to which is attached a series of perforated iron buckets, each with a shovel-shaped steel mouth projecting considerably on one side. The overhanging framework forms an inclined plane along which the buckets run, descending on one side and ascending on the other. They are so arranged that they descend empty, and on reaching the bottom the projecting shovel or scoop-mouth digs into the bottom and partially fills the bucket with the silt; it then turns round on the wheel at the lower end of the incline, and runs up it till near the top, when it turns over the upper end, and in doing so its contents are emptied into a second attendant barge. This action is continued by every succeeding bucket of the endless chain. The perforations are for the passage of the water. By varying the inclination of the framework, the working depth may be increased or diminished. Some dredges are fitted with two complete sets of buckets, one on each side of the vessel. A steam-engine and boiler, suitably placed in the dredge, are provided for giving motion to the machinery, and sometimes also to a screw-propeller placed at the stern. The Frisbie engine, shown on page 503, is much used for dredging purposes in the United States. The manner of connecting the spur-gearing to the drums by bolting directly to the rim of the drum does away with all torsion of the shaft and wear upon all keys and feathers, which is a serious defect in most hoisting-engines, causing shafts to split at the key-way. A friction-clutch is set so as to do the work at which the cables are safe, and then slip, and save the engine and gearing from breaking. The motion to operate the clutch is easy and natural; and with a very powerful strap-brake, the engineer can hold or lower carefully any load he can hoist.

Perhaps nowhere has river-dredging been carried such a length as in the case of the Clyde, which by this process of scooping has at and below Glasgow been converted from a river navigable only for small vessels into an estuary capable of bearing the largest ships. The dredges employed for this purpose are moved by steam, the materials scooped out being carried out to sea by lighters. These have a large open tank amidships, while the two ends are decked over, and afford such accommodation for crew or machinery as may be necessary. The sides of the hold are hinged from the top, and open outwards, and thus its contents can easily be emptied into the sea.

The engraving on the opposite page represents a new description of dredging-machine, known as the *boom-dredge*, of which the Osgood Dredge Company, Albany, N. Y., are the patentees and builders. In view of its valuable peculiarities and the marked success which has attended its use, both as to efficiency and economy, we give this illustration and a brief statement of its construction and operation, as matters of interest to readers practically acquainted with this class of machines. The main hull is 80 feet long, 17½ feet wide, and 5½ feet deep. On either side of the hull is attached



a ponton 5 feet in width and with other dimensions the same as those of the hull proper. These pontons can be moved when necessary, to permit the dredge to go through locks. When attached to the hull they give a total width of 27½ feet. The hoisting-engines have two cylinders, each 11 inches bore and 18 inches stroke. The boiler is of locomotive pattern, with a donkey-pump to feed it. The supply- and exhaust-pipes are made with expansion-joints. The sides of the hull have wooden trusses of the Howe pattern to give strength and stiffness. The dipper is made of steel and has a capacity of 46 cubic feet. It is made with a patent double door. The outer door, instead of being hung at the lower edge of the dipper, is hung about the middle, so that in opening it hangs down about half the distance it would if hung in the usual way. This diminishes by so much the height to which it is necessary to raise the dipper in order to dump it. The other and smaller door opens inward and allows the dipper, as it strikes the water, to fill from the bottom, thus taking away much of the shock ordinarily experienced with the old style of dipper when striking the water. The old style of dipper fills from the top. The dipper-handle has neither rack nor pinion, but is worked by friction applied through a hand-wheel on the turn-table. The capacity of this machine is two dippers per minute. The hoisting-chain is a single one and is made of 1¼-inch steel. The "A" frame and the boom are made of angle-iron, riveted together, and are so arranged that they can be raised or lowered by steam-power, so as to permit the dredge to go under bridges without being taken apart. The raising and lowering are performed by chains attached to independent drums, which are operated by the main engines. The spuds are raised by steam-power, by means of chains attached to friction-drums. These drums are also operated by the main engines. The spuds are kept in place after being lowered by patent eccentric binders, which hold the spuds firmly and without any slipping. The spuds go down in wells through the boat, the wells being absolutely water-tight. The after-spud is a "trailing" one. This keeps the machine in line when the forward spuds are raised and the machine is moved ahead. The main hoisting-drums are worked by a novel hydraulic from which satisfactory results have been obtained. The friction can be instantly applied and taken off. The power for this is the combined force of steam and water pressure. This friction is easily applied, and is one of the best features of the machine. By means of it much of the fatigue to the operator incident to the style of "V" and other frictions is avoided. This is no inconsiderable item in the working of a machine during ten consecutive hours. It is an admirable labor-saving appliance. See *Boom-dredge*, *Crane-dredge*, and *Excavator*.



Frisbie Hoisting-engine.

DRESS.—1. A word of command for alignment of troops; also a term expressing the alignment itself. 2. The clothing termed regimentals issued to soldiers. The dress should be light and easy, not encumbering the arms or legs in any way, but leaving the soldier free to shoot and walk. The dress, moreover, should be adapted to the climate of the country in which the soldier serves. The *dress uniform* is the dress prescribed for occasions of ceremony. See *Uniform*.

DRESS-COAT.—A part of the full-dress uniform. In the United States army all officers wear a double-breasted *frock* coat of dark blue cloth, the skirt extending from one half to three fourths the distance from the hip-joint to the bend of the knee. *For a General.*—Two rows of buttons on the breast, twelve in each row; placed by fours; the distance between each row five and one half inches at top and three and one half inches at bottom; stand-up collar, not less than one nor more than two inches in height, to hook in front at the bottom and slope thence up and backward at an angle of thirty degrees on each side, corners rounded; cuffs three inches deep, to go around the sleeves parallel with the lower edge, and with three small buttons at the under seam; pockets in the folds of the skirts, with two buttons at the hip and one at the lower end of each side edge, making four buttons on the back and skirt of the coat; collar and cuffs to be of dark blue velvet; lining of the coat black. *For a Lieutenant General.*—The same as for a General, except that there are ten buttons in each row on the breast, the upper and lower groups by threes, and the middle groups by fours. *For a Major General.*—The same as for a General, except that there are nine buttons in each row on the breast, placed by threes. *For a Brigadier General.*—The same as for a General, except that there are eight buttons in each row on the breast, placed by pairs. *For a Colonel, Lieutenant Colonel, and Major.*—The same as for a General, except that there are nine buttons in each row on the breast, placed at equal distances; collar and cuffs of the same color and material as the coat. *For a Captain, First Lieutenant, Second Lieutenant, and Additional Second Lieutenant.*—The same as for a Colonel, except that there are seven buttons in each row on the breast. *For all Storekeepers.*—The same as prescribed for officers of the same rank in the Quartermaster's, Medical, and Ordnance Departments. This coat is worn on all dress occasions, such as reviews, inspections, dress-parades, guards, and courts-martial. It is habitually worn at battalion drills, except in hot weather, or when otherwise directed by the Commanding Officer. It may also be worn with shoulder-straps when not on armed duty.

For Enlisted Men of Infantry.—The dress-coat is single-breasted, dark blue basque, according to pattern deposited in the Quartermaster General's Office, piped with sky-blue; collar same height as for officers' coat, faced with sky-blue cloth four inches back on each side, cut square to hook up close in front; number of regiment or badge of corps in yellow metal in middle of sky-blue facing of collar on each side; skirt of coat on each side of opening behind to be faced with sky-blue cloth, ornamented with four buttons, as per pattern. Two straps of dark blue cloth, piped with the same color as the facings, let into the waist-seam on each side the coat and buttoning above the hip to sustain the waist-belt; shoulder-straps of cloth the color of the facings let into the shoulder-seam and to button over the shoulder-belts at the collar-seam with one button; shoulder-straps for Engineer soldiers to be scarlet, piped with white. *For Enlisted Men of Artillery, Engineers, and Ordnance.*—Same as for Infantry, except that the facings shall be scarlet for Artillery, scarlet and white for Engineers, and crimson for Ordnance. *For Enlisted Men of Cavalry and Light Artillery.*—Same as for Infantry, excepting that it is shorter in the skirt, and the facing upon the skirt put on differently, according to pattern in the Quartermaster General's Office; facings for Cavalry yellow, and for Light Artillery red. *For Musicians.*—Ornamented on the breast with braid same color as the facings, running from the button as now worn, the outer extremities terminating in "herring-bones" and the braid returning back to the buttons. *For Hospital Stewards.*—Same as for Infantry, except the facings to be of emerald green. *For Ordnance Sergeants.*—Same as for enlisted men of Ordnance. *For Commissary Sergeants.*—The same as for Infantry, except that the facings will be cadet gray. *For Enlisted Men of the Signal Service.*—Same as for Cavalry, except that the trimmings and facings will be orange. Whenever the dress-coat is worn by enlisted men, it is invariably buttoned up and hooked at the collar. See *Blouse* and *Uniform.*

DRESS-PARADE.—A daily parade of troops in the United States army at *troop* or *retreat*, as the Commanding Officer may direct, and which is never dispensed with except on urgent occasions. All Field Officers and men are present, unless specially excused, or on duty incompatible with such attendance. The ceremonies of dress-parade are conducted as prescribed in the authorized Tactics, and are as follows for a regiment:

At the second signal for dress-parade, the companies assemble under arms on their respective parade-grounds, and are inspected by their Captains; the inspection being completed, *adjutants' call* is sounded, at which the line is formed on the battalion parade-ground, bayonets fixed. The Commanding Officer takes his post at a convenient distance in front of the center, facing the line. The Adjutant, having commanded *guides posts*, directs the first Captain to bring his company to *parade rest*. The Captains, commencing on the right, successively face about and command: 1. (Such) *company*, 2. *Carry*, 3. ARMS, 4. *Order*, 5. ARMS, 6. *Parade*, 7. REST, resume their front, and take position of parade rest; the Adjutant then takes his post, commands, SOUND OFF, and takes the position of parade rest. The band, commencing on the right, plays in quick time, passing in front of the Field Officers, or Company Officers if there be no Field Officers, to the left of the line, and back to its post on the right; at evening parade, after the strain is finished, retreat is sounded by the trumpeters or field music. The Adjutant then steps two yards to the front, faces to the left, and commands: 1. *Battalion*, 2. ATTENTION, 3. *Carry*, 4. ARMS, 5. *Rear open order.* Having aligned the guides for the rear rank, the Adjutant steps three yards to the front of the front rank, faces to the left, and commands: 6. MARCH. At which the ranks are opened. The Adjutant, having verified the alignment of the officers, the ranks, and the file-closers, returns to the right of the front rank, faces to the left, commands, FRONT, and then passes in rear of the line of Company Officers to the center of the battalion, turns to the right, and marches to a point midway between the line of Field Officers and the Commanding Officer, when he halts, faces about, and commands: 1. *Present*, 2. ARMS. At the second command, the officers and men present arms. The Adjutant then faces about, salutes the Commanding Officer, and reports: "*Sir! the parade is formed.*" The Commanding Officer returns the salute with the right hand, and directs the Adjutant: "*Take your post, Sir.*" The Adjutant takes his post three yards to the left and one to the rear of the Commanding Officer, passing by his right and rear. The Commanding Officer, while the band is playing, stands at parade rest, with his arms folded, in which position he continues till arms are about to be presented, when he comes to attention. The Adjutant having taken his post, the Commanding Officer draws his sword, commands: 1. *Carry*, 2. ARMS; and adds such exercises in the Manual of Arms as he may desire, concluding with *order arms.* He then directs the Adjutant to receive the reports, and returns his sword. The Adjutant passes by the right of the Commanding Officer, advances toward the line, halts midway between him and the line of Field Officers, and commands: 1. *First Sergeants*, 2. *To the front and center*, 3. MARCH (or, *double time*, MARCH). At the first command, the First Sergeants carry arms; at the second command, they step two yards to the front and face toward the center; the Drum Major at the same time faces to the left; at the third command, the First Sergeants and the Drum Major march to the center, and successively face to the front; the Adjutant then commands, *Report.* At this command, the Drum Major and the First Sergeants, commencing on the right, successively salute and report: the Drum Major, *Band and trumpeters*, or *field-music, present, or accounted for*, or (so many) *musicians*, or *trumpeters, absent;* the Sergeants, *Company* (A, etc.) *present, or accounted for*, or (so many) *sergeants, corporals*, or *privates absent.* The reports being made, the Adjutant commands: 1. *First Sergeants*, 2. *To your posts*, 3. MARCH (or, *double time*, MARCH). At the command *march*, the First Sergeants and Drum Major face outward, and resume their places; the First Sergeants pass through their intervals a yard to the rear, face about, step into the front rank, and then order arms. The Adjutant now faces about, salutes the Commanding Officer, and reports: *Sir! All are present or accounted for;* or *Sir!* (so many) *officers* or *enlisted men are absent.* The Commanding Officer acknowledges his salute, and directs: *Publish the orders, Sir*, when the Adjutant faces about and commands: *Attention to orders.* He then reads the orders, after which he faces about, salutes the Commanding Officer, and reports: *Sir! The orders are published.* The Commander acknowledges the salute, and then directs: *Dismiss the parade, Sir!* at which the Adjutant faces about and commands: *Parade is dismissed.* At this command, all the officers return their swords, and face toward the center; the officers then step off at the same time with the Adjutant, close upon the center, and successively face to the front, the Field Officers on the flanks; the two officers nearest the center preserve an interval for the Adjutant, who passes through the interval a yard to the rear, when he halts, and faces about; all the officers having faced to the front, the Adjutant steps into his place and commands: 1. *Forward*, 2. *Guide center*, 3. MARCH. At the third command, they march to the front, dressing on the center, the band playing; on approaching the Commanding Officer, the Adjutant commands: 1. *Officers*, 2. HALT. At the command *halt*, given at six yards from the Commanding Officer, the music ceases, and the officers halt, and salute with the right hand. The hands remain at the visor till the salute is acknowledged, and drop at the same time with the hand of the Commanding Officer. The Commanding Officer then gives such instructions as he may deem necessary, which concludes the ceremony. As the officers disperse, the music is resumed; the First Sergeants step to the front and close the ranks of their respective companies; the Third Sergeant of each company places himself on the right of the front rank, the First Sergeants then march their companies to the company parade-grounds, where they are dismissed, the band continuing to play till the companies clear the battalion parade-ground. When the line at parade is very short, the band may play in common time; or it may play to the left in common time, ceasing during the countermarch, upon the completion of which, without halting, it strikes up in quick time. See *Evening Parade, Morning Parade*, and *Undress Parade*.

DREYSE NEEDLE-GUN.—A breech-loading small-arm having a fixed chamber closed by a movable breech-block which slides in the line of the barrel by direct action. It is opened by raising the handle of the breech-bolt to a vertical position, and then withdrawing it to the extent permitted by the form of a slot in the receiver in which it slides. In turning up the handle, the needle-bolt is forced back against the pressure of the mainspring which surrounds its stem, by means of a spiral shoulder near its head, which rides over a corresponding helical surface on the stem of the recoil-block. The needle-bolt is compelled to turn with the breech-bolt by means of a projection on its head which slides to and fro in a longitudinal groove in the bore of the breech-bolt; and the recoil-block is prevented from turning with the breech-bolt by a similar projection sliding in a corresponding groove in the receiver. When fully forced back and the pressure of the hand removed, the needle-bolt is kept from being thrown forward by the main spring by means of a square portion of its face coming against a corresponding part of the back surface of the recoil-block. Supported in this way, the needle-bolt moves back with the other parts during the opening of the piece. When the breech is closed by the usual means the needle-bolt catches against the nose of the sear, and is retained by it.

By the act of turning down the handle into place, the square end of the needle-bolt is rotated off its bearing on the stem of the recoil-block, leaving the needle-bolt and the needle free to be driven forward by the mainspring, when the sear is pulled out of its way by the trigger, as in the *Prussian* needle-gun. It is also locked in the same manner as this gun. The arm may be cocked without opening it, if so desired, by drawing back the needle-bolt by means of a thumb-piece, until the nose of the sear catches against a fillet on the needle-bolt as before described. By then pressing forward the thumb-piece till a stud on its upper surface engages in the transverse arm of an L-shaped slot in the breech-bolt, the mainspring is compressed, and may be released as above described. The thumb-piece and needle-bolt are connected together by the needle, which passes through a small hole in the base of the thumb-piece, and is screwed into the rear end of the needle-bolt.

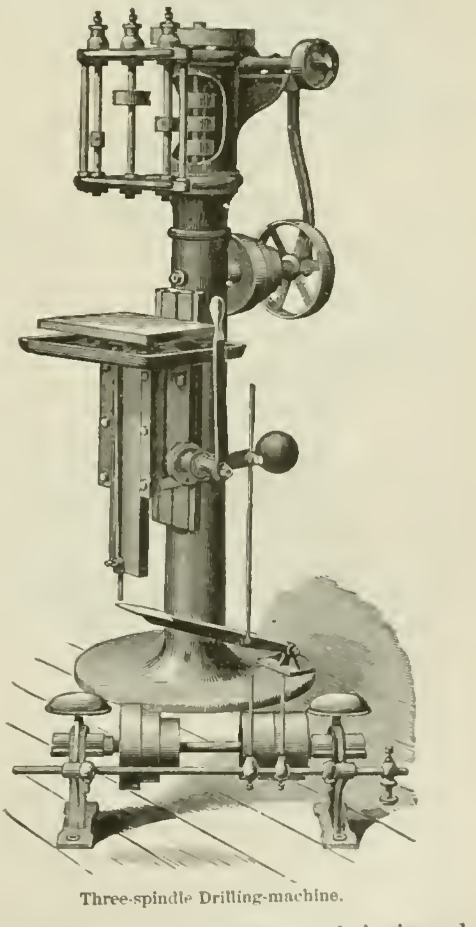
DRIFT.—1. A round piece of steel, made slightly tapering, and used for enlarging a hole in a metallic plate by being driven through it. The drift may have a cutting edge merely upon its advance-face, or it may have spirally-cut grooves which give the sides of the drift a capacity for cutting.

2. A passage in a mine, horizontal or very nearly so, forming a drain for carrying off the water. The name is derived from its being *driven in*. *Driving* is horizontal work; *sinking* and *rising* refer to the direction of work either in shafts or in following the course of a vein.

3. A gun-implement made of steel; it is used for clearing the vent when choked. In using it, a hammer must be applied to the head of the drift to drive it through the vent. There are also wooden drifts, which are used in inserting the *papier-maché* wad in common shells for rifled guns.

4. A deviation peculiar to all oblong rifle-projectiles. See *Projectiles*.

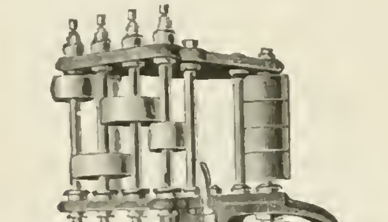
DRILLING-MACHINE.—A machine carrying a rotating tool and a means for chucking the object to



Three-spindle Drilling-machine.

be bored. These machines differ greatly in size and appearance, in the mode of presenting the tool and chucking the work. The larger machines are known as boring-machines. The drawing represents a three-spindle drill, handy for work on a variety of small parts of fire-arms. The spindles of all the gang-drills run in gun-metal boxes, split, and furnished with a nut to compensate for wear. They may be run at the highest speed of which the machine is capable, without danger of binding in the boxes, the longitudinal expansion not being checked by a fixed collet, but being allowed freedom without impairing the accuracy of the machine. The machine has an adjustable hand-lever, a foot-lever, a counterbalanced table, adjustable stop, and gauge for determining the depth of the hole to be drilled. The spindles are of steel—in the smaller machine 13/16 inch diameter, and in the larger machine $1\frac{1}{16}$ inch diameter. The first drills holes up to $\frac{5}{16}$ inch diameter, and the latter up to ½ inch diameter. For heavier work the spindles may be geared. Both sizes are made with two, four, and six spindles. Distance between table and end of spindle in the machines, 5 to 18 inches and 6 to 20 inches respectively. Weight, with countershaft, 625 pounds and 975 pounds. Speed of countershaft, with 8 by 4 inch tight and loose pulleys, 310 revolutions per minute. See *Boring-machine, Chucking-machine, Flexible Shaft, Multiple Drill, Portable Drill, Radial Drill,* and *Vertical Drill.*

DRILL-PRESSES.—Under this head are classed all machines used for boring in which the cutters revolve



and the work remains stationary. Some of the machines classed under the head of drill-presses are known as boring-machines, the word "bore" being commonly applied to holes of a size requiring the use of independent cutters inserted in a "boring-bar." A power-feed is essential to all machines for cutting metal. The drill-press is no exception to this; yet it is almost the only machine-tool which has commonly been built with a hand-feed only. The conditions of cut and variations in the size and strength of the cutting tool make the application of an automatic feed to a drill-press a more difficult matter than to a lathe or a planing-machine, in which a given-sized cutting tool of sufficient strength to do the work is possible. In a drill-press, the smaller and more delicate the drill the finer and more exact or uniform must be the feed. The requirements of a good feed-motion for a drill-press are, that it may be quickly adjusted to the required amount; that it shall be positive in its action when at work; that its range shall be so great, and so fine a feed possible, as not to endanger the smallest drill, while at the same time it shall be capable of giving the utmost amount of feed a large drill or a boring-bar will stand; that it shall be so quickly and readily applied as to make its use more convenient than the hand-feed; and that it shall not in any way interfere with the quick operation of the machine by hand. William Sellers & Co. have recently introduced an improved feed-motion, which fully satisfies all the requirements of a feed for drilling-machines. In their drill-presses, disks of metal are employed to transmit motion by friction, which, being adjustable as to diameter of driving and driven wheels, admits of an infinite variation of feeds between its extreme limits of greatest and least motion. This peculiar feed-motion is applied to those drill-presses in which range is desirable; but in machines for special work, such as for drilling steel plates, the feed is constant at what has been found to work the best, as the size of the drill used in such machines is in a measure constant also. In vertical drill-presses the spindle should be counterbalanced. This is of great value, as the drill held up by the balance-weight will not drop into holes or cavities in the metal, and is much less liable to break.

The drawing shows a four-spindle drill-press, as made by Garvin & Co., for use in government armories. The machine is very heavy, and designed for drilling holes ranging from ¼ to ⅞ inch diameter, also for counterboring, reaming, face-milling, or any work that is convenient to be done on an upright drilling-machine. The spindles are made of steel, $1\frac{5}{16}$ inch diameter and 20 inches long, and are held down by adjustable hardened steel steps at top of frame. The lower end has a taper hole to receive the shanks of tools, ⅞ inch diameter and 4 inches deep, with mortise for drift-key to remove the tools from the spindle. The spindles run in composition-metal boxes fitted up in a very substantial manner, with ample means of adjustment for wear. The head which holds the spindles, drum, and cone-pulley is located centrally over the upright column, giving a well-balanced appearance and sufficient distance between the drum and spindles to insure long belts of great power and durability. The table on which the work is placed has hand and foot levers connected by a milled rack and gear to elevate and lower the table, in connection with adjustable stops to limit the exact motion required. The hand lever can be placed in any position required by loosening the nut outside the friction binder on the pinion-shaft, and should be screwed up firmly again when adjusted. The table guide-frame is planed to fit the front of the column by tongue-and-groove guides, so that the whole table and frame, with all the attachments, can be raised or lowered up or down the column by means of a wire cable with a worm and gear, and can be held in a true position at all points. The advantage of this arrangement is that we may have a press with a very long distance from the spindle to the table, or a very short one, simply by loosening four nuts and locating the table-frame where it is most convenient, and tightening the nuts again. The countershaft has adjustable self-oiling hangers. The weight of the press, with countershaft, is about 1200 pounds. See *Drilling-machine* and *Vertical Drill.*

DRILLS.—A general name for the exercises through which soldiers are passed, to qualify them for their duties. It is subject to numerous varieties, according to the number and organization of the men drilled at one time, and the kind of weapon to which the exercises relate. The infantry, the cavalry, and the artillery, all have different kinds of drill. The militia and the volunteers differ from the regulars, if not in the kind of drill, at least in the circumstances under which it is carried on; the squad-drill, company-drill, and battalion-drill vary both in the numbers concerned and in the routine of exercises. And so likewise in the navy, the drilling of seamen varies in kind, according to the duties likely to be required. It is generally considered that four months' drill is required to fit an infantry recruit for service. The progress depends greatly on the intelligence of the men. It is on this ground that the Rifle Volunteers, enrolled in England in such large numbers in 1860, have been so advantageously placed; composed almost entirely of young men, whose intelligence has been developed by a moderately good education, the Corps have advanced to a degree of proficiency which has attracted the marked attention of military officers.

DRILL-SERGEANT.—A non-commissioned officer whose office is to instruct soldiers as to their duties, and to train them to military evolutions. In the English service the name is given to a non-commissioned officer whose duty it is, under the orders of the Adjutant, to attend to the drill-instruction of young officers and soldiers

DRIVER CORPS.—A Corps formerly consisting of a few subaltern officers, with non-commissioned officers, artificers, drivers, and horses. It was divided into troops, and provided the means of converting a company of foot-artillery into a field-brigade, besides affording small detachments to troops of horse-artillery.

DRIVERS.—Men attached to a battery of artillery to drive the horses. They do not work the guns, but, when they can be spared, are taught the gun-drill. The men enlisted as drivers are of shorter stature than gunners, as height and weight are not required. When men are enlisted as gunners, if they do not fulfill the conditions as to age and standard, they may be entertained as drivers, if likely to become good drivers, but special application must be made to the Adjutant General. In the early days of artillery, both in the English and Continental armies, regularly enlisted drivers were unknown. The horses attached to guns were driven by civilian drivers, who were in the habit of running away on the first available opportunity, and in doing so at the battle of Falkirk, lost the guns. But notwithstanding this catastrophe, it took half a century and upwards before matters in any way righted themselves, and even then, though a vast improvement had taken place upon the old system of dismounted civilians, great confusion in the organization existed. The drivers were enlisted in a corps totally distinct from the regiment, and commanded by their own officers; the drivers were thus separated by a wide gulf from the gunners; this want of connection between the field-artillery and its means of draught led to discord, confusion, and waste of time. In 1817 the drivers were first placed under the command of the artillery officers, and in 1822 men were enlisted into the regiment as gunners and drivers.

DRIVING.—In its usual sense, driving is the act of impelling or directing draught-cattle; it is seen in the act of a driver urging or impelling his horses on. The term is also commonly used in the management of an engine attached to a railway train. In the laboratory the word is applied to the mode formerly, and to some extent at the present day, of filling fuses, port-fires, and rockets with composition. The term is also used in mining, when constructing a gallery. And, frequently, the word is used to express the *driving-side* of the grooves of a rifled gun, in contradistinction to the *loading-side*.

DROMEDARY.—A name sometimes given, probably at first through mistake, to the Arabian or one-humped camel (*Camelus dromedarius*), but properly belonging to a variety of that species, distinguished by slenderness of limbs and symmetry of form, and by extraordinary fleetness. It has been well described as "bearing much the same relation to the ordinary camel as a race-horse or hunter does to a cart-horse." The pace of the dromedary is a trot, which it can maintain without intermission for a prodigious length of time, often at the rate of nine miles an hour for many hours together; whilst a journey of upwards of six hundred miles is performed at a somewhat slower rate in five days. Even its more rapid pace can be maintained for twenty-four hours at a stretch, without sign of weariness and without stopping to bait; and if then it is allowed a little refreshment, of a ball of paste made of barley and powdered dates and a little water or camel's milk, it will resume its journey, and go on with undiminished speed for twenty-four hours more. The jolting to the rider is terrible. The gallop is a pace very unsuitable to the dromedary, and at which it very soon fails. Dromedaries are sometimes trained to run races. White dromedaries are particularly prized in some portions of the East. See *Camel* and *Draught-animals*.

DROOPING.—In artillery, a term applied to the wearing away of the muzzle of smooth-bore guns, especially bronze guns, after long firing. Drooping occurs from the gun having much windage, and not alone from the cause hitherto given, viz., quick firing and consequent heating of the piece. This defect is not likely to happen to rifled guns, as they have little or no windage; moreover, the barrel of rifled guns, being of steel, is not so liable to wear away as gun-metal. There is a method now of condensing the bores of bronze ordnance.

Drop of a Gun.

DROP.—1. The distance of the butt of a gun below the prolongation of the rib. It varies from two to three inches. To measure the drop, get a straight-edge narrow enough to lay along the rib of the gun, and long enough to reach from the sight of the gun over and beyond the butt. After being particular that the straight-edge lies along the rib and touches it at the muzzle and breech, take the measurements from 1 to 2 and 3 to 4, which will give the drop. 2. In fortification, that part of the ditch sunk deeper than the rest, at the sides of a caponiere or in front of an embrasure.

DROP-CHRONOGRAPH.—In the course of the trials made on the working of the apparatus for measuring pressures, called accelerographs, the construction of a tarage apparatus was suggested, founded on the law of the falling of bodies and presenting arrangements borrowed from the two drop-chronographs which Mr. Le Roux has described in his studies on the measurement of the velocity of the transmission of sound through pipes. The addition to this apparatus of electric organs, and especially of Marcel-Deprez registers, has converted it into a very convenient chronograph, adapted with advantage to measurements in which as great precision is sought as that which may be reasonably required with the tuning-fork chronograph. This drop-chronograph has, therefore, been frequently used in the trials made at the Sevran powder-mill for the study of the different phenomena connected with the firing of guns and the working of carriages. It affords, for example, a means of studying the retardation of inflammation of the charge, of determining the precise moment of the first displacement of the projectile or of the beginning of the recoil, and the moment when the carriage attains its maximum of velocity; it also affords means of measuring the velocity of projectiles with a precision little inferior to that of the Le Boulengé chronograph, and gives besides the means of noting their passage through a series of successive frame-targets; finally, it affords a means also of noting the instants of the passage of a projectile in different points of the bore by means of special interrupter organs. We will therefore describe this apparatus here, which, for the simplicity of its construction and management, and the multiplicity of applications to which it is adapted, deserves a place in all practice-grounds, and could, with equal advantage, be introduced in many scientific laboratories. We will notice incidentally some of the experimental adaptabilities realized with this apparatus, in order the better to apprehend the various applications of which it is susceptible.

The drop-chronograph, which was constructed by the works of Mr. Bianchi, of Paris, is represented in Figs. 1 and 2. It is composed essentially of a weight which falls freely between two vertical guide-posts, and which sometimes receives on its own surface the traces left by the apparatus whose movement is the object of study, and sometimes draws with it the electric registers, which leave on the guide-posts traces of the signals which it is desired to obtain. The apparatus is arranged for receiving on one of its faces the organs designed for the first mode of working, and on its other face the organs of electric registration; there is then on one side a mechanical registering chronograph, and on the other an electric chronograph. The mechanical registering chronograph has been especially used, in the researches in which we are engaged, for tarage operations of the accessory organs of the ballistic apparatus, accelerograph-slides, forks, and vibrating plates. The two vertical guide-posts of the apparatus are formed of double T-iron, about 2 meters (6.562 feet) high, and connected at their upper and lower end by cross-pieces, to which they are fastened with screws in such a manner that the distance between them can be slightly varied. In the inside there are two copper rods, perfectly upright, with a V-shaped groove; they serve as guides for the projecting ears of the movable weight. The mounting ought to be adjusted so that the space between these guides is a little less above than at the bottom, so that the weight may have very little play at the upper part, while it is left absolutely free in its fall if the system is placed exactly perpendicular. The whole apparatus rests on a circular base provided with three adjusting-screws, by which the verticalness can be established, and a thread, with a cylindrical plummet fixed on the side, passes through an eye of the same form a little larger in diameter, by which this condition is verified every instant. The weight, of parallelopipedic form and weighing about 10 kilograms (22.046 pounds), is suspended by a hook from a movable cross-piece; this is secured by a clamp-screw at any height on the guide-posts.

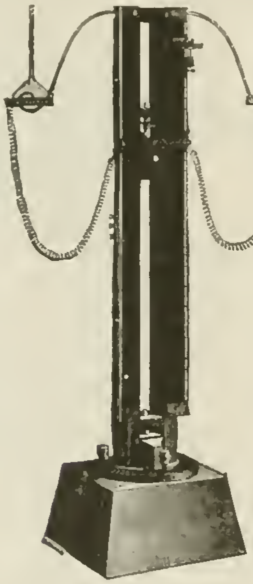


Fig. 1.

The suspension-hook forms part of the lever, the other arm of which bends round horizontally; bearing down on this arm suffices to liberate the weight, and the form of the hook is contrived in such a manner that this operation is effected without producing an oblique action, and without modifying the initial height of the weight until the moment when it is set free. This result is obtained by shaping the inner face of the hook according to an arc of a circle whose center coincides with the center of rotation of the lever, and by placing the edge of the counter-hook, which holds the weight, on the same axis. The weight has, on its front vertical face, two checks, which serve as supports for a horizontal shaft, set with strong friction. This shaft extends, on each side, beyond these checks, so as to form two cylindrical supports on the opposite posts of the apparatus, and on which Marcel-Deprez registers can be mounted side by side. These registers may be five in number on each side, but generally only the number strictly necessary, according to the nature of the experiment in view, is used. The electric wires connecting with each register are of very fine copper covered with silk; they are collected, on each side, into a cluster spirally arranged and sustained by a support attached to the upper part of the apparatus; the whole is arranged in such a manner as to permit the movement of the weight, through the whole extent of its course, without encountering any sensible resistance. On each support the wires connect with small terminals mounted on wood, and which permits each register to be easily secured to the ordinary conductors. On the front faces of the guide-posts are fixed two nickel rules, which may be covered with lamp-black, and on the surface of which the pens of the registers rest, which, during the fall of the weight, trace each a very fine vertical path which is clearly defined on the lamp-black. The pens are so fine and flexible that the pressure exerted by their points cannot sensibly affect the movement of the weight in its fall. In order to facilitate the regulation of this support, and, in case of need, to release all the pens at the same time, the shaft is furnished with a handle by which it is turned in its bearings, and a screw which regulates its movement by bearing against the outer face of the weight. The registers also possess each an individual movement of rotation on the shaft which sustains them, because each of them is mounted on a divided ring-brace forming a clasp at the lower part; this brace is clasped on the shaft, and can be tightened or loosened at will by means of a mill-headed screw which unites the two branches of the clasp. It remains to show how it happens, in the application of this apparatus to ballistic experiments, that the phenomenon to be observed, which results from the inflammation of a charge of powder, is produced during the fall of the weight. It is easy to produce ignition of the charge by electricity, and to close the current which produces ignition by a single passage of the weight in front of a special arrangement which can be placed at any desired height upon one of the guide-posts. Fig. 1 shows this organ. It is composed of an insulating plate mounted on a metallic guide, which can be

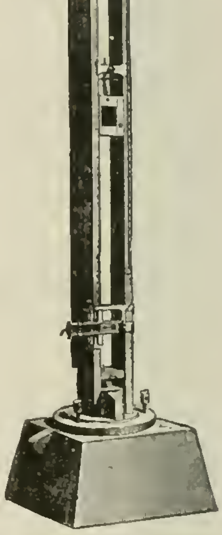


Fig. 2.

moved along a guide on the left guide-post of the apparatus, and can be firmly secured at any height by means of two clamp-screws. The insulating plate has a brass spring-plate, bent round vertically, which rests firmly, when it is left free, against the extremity of a contact-screw. It is the contact of this plate and screw which establishes the current of the firing-battery; the two contact-pieces are for this purpose put in communication with two terminals which receive the extremities of the wire for communicating fire. In order to interrupt this current a light steel lever is used, pivoting in a vertical plane, and forming a hook which catches under a notch made on one of the edges of the conductor-spring, and thus keeps it at a distance from the contact-screw. This lever is extended in front so as to meet the extremity of the axis which supports the registers when the weight falls. It is then carried down and sets free the spring which abuts against its stop, and thus establishes the ignition-current. It is evident that if we know approximately the retardation of ignition, that is to say, the time that elapses between the precise instant when the current is closed and that when the charge takes fire, and if the time also is known approximately that elapses between this latter moment and that when the phenomenon to be observed is produced, we can, by moving the organ for communicating fire along the guide-post, obtain the inscription of the signals in that part of the course of the movable weight which seems most proper, and, consequently, when this weight shall have taken a velocity sufficient to assure the precision of the readings. This same organ for communicating fire has been completed by a simple arrangement which gives the means of measuring, in the course of each experiment, the retardation of disconnection of the registers mounted on the chronograph. This arrangement consists in the addition of a mass of brass fixed at the extremity of a light spring, and which rests against the front face of the spring for communicating fire. This mass, impelled by the movement of this latter spring, when it is set free remains in contact with it during its movement; but as soon as it is arrested by the screw it separates from it, continuing its force by virtue of its inertia, while the spring which urged it so far suddenly becomes stationary. Thus a rupture of contact is obtained at the very moment when, on the other hand, the contact of the detent-spring is established with the stop-screw. At the end of a little time the inert mass resumes its place under the influence of a very weak spring, of which it forms a part. This spring ends at a special terminal, to which a conductor-wire is fixed.

When it is desired to obtain more precision with the drop-chronograph, a vibrating fork can be mounted on the shaft designed to support the registers; one of its branches is furnished with a pen which traces on the lamp-black and produces a sinusoidal tracing whose successive undulations each represent the course of the weight during a unit of time equal to the vibration of the fork. It may be admitted that the movement is approximately uniform during the continuance of each of these vibrations, and supposed that in passing from one to the other it suddenly takes the increase of velocity which the force of gravity communicates and which measures precisely the augmentation in length of the undulatory tracings; by simply counting the vibrations which separate the signals, the corresponding durations can be directly estimated by the entire number of vibrations, and determined, with the aid of a microscope, by a simple proportional calculation like the supplementary durations which correspond to fractions of vibration with the fork-chronograph with revolving cylinder. The fork, mounted thus on the movable weight, may be sustained electrically. But considering the short total duration of the fall of the weight whose movement is to be registered, and if it is proposed to estimate, as is usually the case, only the durations comprehended between the successive signals, it is more simple to employ an ordinary fork mounted by means of a split band forming a vise on the support of the registers and whose vibratory movement is provoked simply by the sudden removal of a small metallic wedge, of suitable dimensions, introduced by force beforehand between its branches. This wedge can be fixed simply to the extremity of a wire fastened at the other end to the upper part of the edge of the apparatus, and whose length must be calculated so as not to withdraw the wedge till the weight has acquired sufficient velocity to produce a sudden impetus. Thus it can only be set in motion a few instants before the

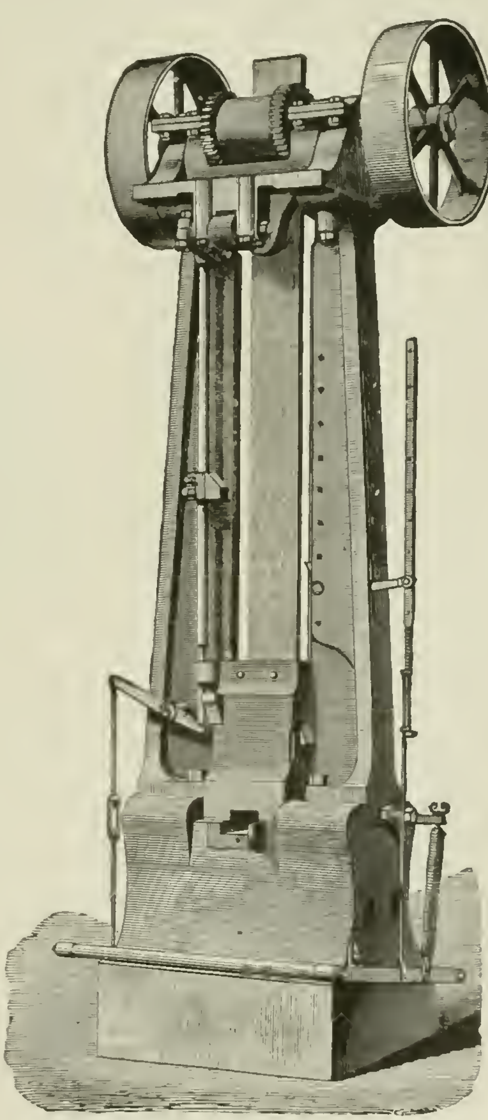


Fig. 1.

moment when the registers are required to work, so that the vibrations have a greater amplitude in the part where the readings are to be made; but sometimes it is expedient to cause this disconnection a certain time in advance (the tenth of a second, for example) in order to leave unemployed the first vibrations, which are subject to some irregularities owing to the position of forced equilibrium which the introduction of the wedge between the extremities of the branches gives to the apparatus. It is well understood, besides, that the wedge must be entered a very little distance and shaped also in such a manner as to require but a very feeble effort to withdraw it, so as to affect the movement of the weight as little as possible; but it is to be remarked that the very principle of the employment of the fork does away with all error that might proceed from this fact, as the tracing left by the pen has the advantage of making known the velocity acquired by the weight at each instant, whatever may be its value. In making use of a vibrating fork, supported electrically and set in operation in place before the fall of the weight, the movement of this weight may be studied along the whole extent of its fall when it has been unobstructed, and it may be ascertained if this movement is according to the law of gravitation, or, in the contrary case, it may be determined how much it deviates from it. In combining the employment of a fork of this kind and an ordinary fork disconnected mechanically by withdrawing the wedge, as was said before, the perturbation that the withdrawing of this wedge gives to the movement may be studied. If, on the contrary, it is admitted that the drop movement of the weight is known, by preserving only this latter arrangement this experiment may be used for determining the number of vibrations given by a fork. The drop-chronograph has been frequently utilized for measurements of this kind. See *Accelerographs*, *Chronograph*, and *Marcel-Deprez Register*.

DROP HAMMER.—A hammer in which the weight is raised by some device and then released, so as to drop upon the object below, which rests upon the anvil. It is used in all Government armories, in swaging, die-work, striking up sheet-metal, etc. In early times the machine was so constructed that the hammer could be raised by means of a hammer-strap, which was drawn upwards by two pulleys, brought together so as to compress the strap between them. One of these, the driving-pulley, was fast upon its axle and turned in fixed bearings, while the other turned loosely upon an eccentrically journaled axis, arranged also in fixed bearings, but so as to be incapable of turning therein except as force was applied to it to effect that object. To one end of the latter shaft there was attached a horizontal arm, the outer end of which was connected to a hand-lever or a treadle by a connecting-rod. By means of these appliances the eccentrically journaled shaft could be turned at will, so as to remove its roller from contact with the strap, and allow the hammer to fall through any length of space desired, within the limits of the machine. The drawing, Fig. 1, on the preceding page shows an efficient drop-hammer, made by the Pratt and Whitney Company, U. S. A. The drop is raised by means of a flat-surfaced strip of tough wood, which engages with the faces of finished cast-iron rolls, driven by gears at the ends. One of these rolls runs in fixed bearings, and the other has its bearings in a yoke suspended on journals which allow it to be moved towards its fellow, to engage with the surface of the lifting-board. This yoke has a central portion projecting downward and engaging by a connecting-bar with a cam operated by a vertical starting-bar through the medium of a crank-lever. By this combination a much greater force is exerted, instantaneously, in placing and retaining the roll in contact with the lifting-board, than is possible when the starting-bar is connected directly with the roll-bearings. The two rolls, with their gears, and the cam movement, are all parts of the head-piece, which may be removed as a whole, or the rolls may be removed separately. The gears are made very strong, and have a peculiar form of tooth, specially adapted to the work they perform. There are two to each roll. An automatic and adjustable stop holds the drop suspended at any height desired. An automatic trip may be attached, which will secure a series of blows of uniform force, at the will of the operator, who can, however, instantly change it from the full impact of the drop falling from the extreme height of the lift to the simple pressure of the weight of the mass without motion. This absolute control and instant adjustment of the force of the blow is appreciated by all practical forgers. The workman has the free use of his hands in operating the machine, as its action is governed entirely by his foot. Experts in the use of the hammer do not attach much value to the automatic trip as having any advantage over the foot-motion, while the latter has many over the former. With each machine is a wrought-iron die-bed secured by a key. This die-bed saves the trouble and expense of dressing the main bed by chisel and file, or by planer, in case of damage, and also adds to the strength of the machine by increasing its resistance to the shock of the blow. The weight of beds may be increased at will.

For all heavy work the steam drop-hammer is now employed. The following drawings show two varieties of double-frame steam drop-hammers, manufactured by the celebrated machine-tool works of Frederick B. Miles, Philadelphia. Fig. 2 is designed for stamping the work in formers. The frames are keyed and bolted to a solid anvil-base, in which is planed the seat for the lower die. The ram carrying the upper die plays between guide-plates, fitted with taper shoes by which they can be accurately adjusted, for the purpose of taking up wear and for matching the dies, which are thus held in the relation to each other necessary for stamping work in molds or formers with accuracy, also for swedging journals or other round work. In this hammer the weight of drop is 100, 400, or 800 pounds; the diameter of cy-

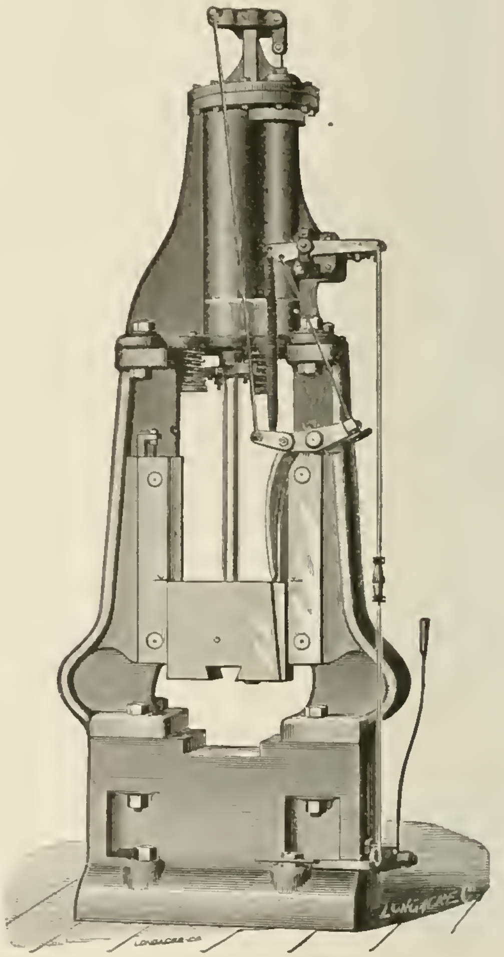


Fig. 2.

linder is 4¾, 6, or 6½ inches; and the length of stroke 10, 14, or 29 inches respectively. Fig. 3 is designed for axles, truck-bars, and heavy drop-forgings, and is both hand-acting and self-acting. Single blows or a succession of automatic blows can be produced at will, and of any required degree of force. The weight of drop is 1500 or 3000 pounds; the diameter

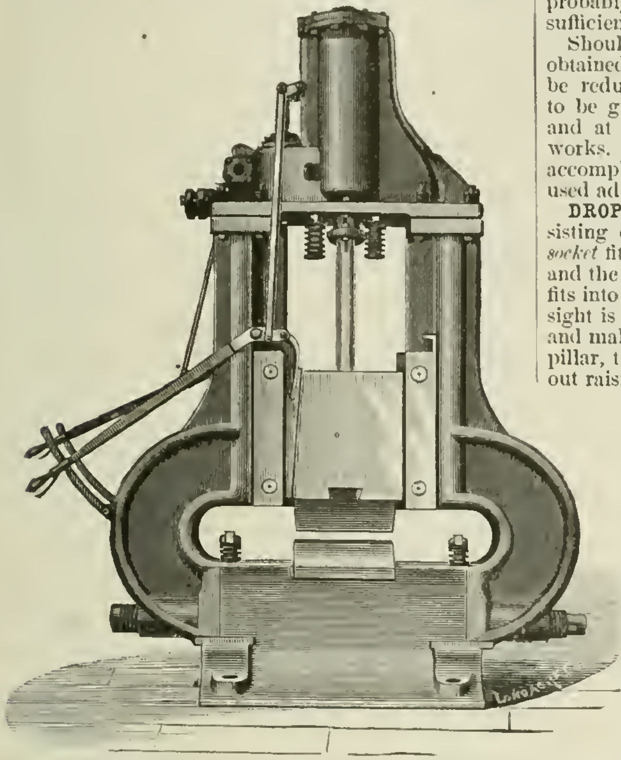


Fig. 3.

of cylinder is 10¾ or 15 inches; and the length of stroke is 30 or 36 inches respectively. These hammers are noted for their adjustable guides and the bumpers made of steel spiral springs. The glands are made in halves for facility of repairs, and brass bushings are introduced in all the principal bearings. See *Steam-hammer*.

DROP OF PROJECTILE.—When seeking protection from the fire of an enemy, either by natural or artificial cover, the *drop* of the projectile must be taken into account. This depends upon the range, kind of piece used, and nature of fire employed.

The following table, showing the *drop* of projectiles at various ranges, indicates the importance of this factor in actual warfare.

Range.	Rifle-musket.		Velocity.	8-inch Rifle.	100-pdr. Parrott.
Yards.	Drop.	Sec'ds.	Feet.	Drop.	Drop.
200	85	0.5	1120	....	...
400	50	1	915	....	57.3
600	30	1.75	800	....	....
700	25	....	....	57.3	28.6
800	20	2.5	700	....	....
1000	14	3.75	625	....	....
1100	..	....	....	....	19
1200	..	....	558	28.6	....
1400	..	....	....	....	14.3
1500	..	....	506	....	....
1600	..	....	....	19	....
1700	..	....	....	....	11.4
1900	..	....	....	....	8.1
2000	4	....	412	14.3	....
2500	..	....	....	11.4	7.1
3000	..	....	....	8.1	5.8
3500	..	....	....	6.3	....
4000	..	....	...	5.1	....
4600	..	...	....	4.1	....

The numbers in the columns "Drop" denote the number of units of horizontal distance to one unit of vertical.

When the distance to the object can be determined and the range is such as to require considerable elevation, it is by no means necessary that the object should be seen from the gun, provided range-points can be accurately established, as in mortar-firing. In many cases it will be a great advantage to locate guns in this manner, for the reason that the enemy will probably not be able to ascertain their position with sufficient accuracy to do them much damage.

Should the distance behind which cover can be obtained be quite short, the charges for guns may be reduced so as to allow the necessary elevation to be given to carry the projectile over the cover, and at the same time drop them into the enemy's works. A few trial-shots will enable the artillerist to accomplish this with certainty. Siege-howitzers are used advantageously in this way. See *Projectiles*.

DROP-SIGHT.—A variety of trunnion-sight, consisting of a socket, collar, pillar, and leaf. The *socket* fits into the gun, the *collar* locks into the socket, and the *pillar*, at the top of which the *leaf* is screwed, fits into the collar. The arrangement for securing the sight is a kind of bayonet-joint: by lifting the collar, and making a quarter-turn from left to right with the pillar, the collar and pillar are drawn out; but without raising the collar, the pillar is immovable in any direction, and must be exactly in its place. The pillar cannot be separated from the collar while the leaf is fixed. See *Sight*.

DROSS.—The *scum, scoria*, slag, or recrement resulting from the melting of metals combined with extraneous matters.

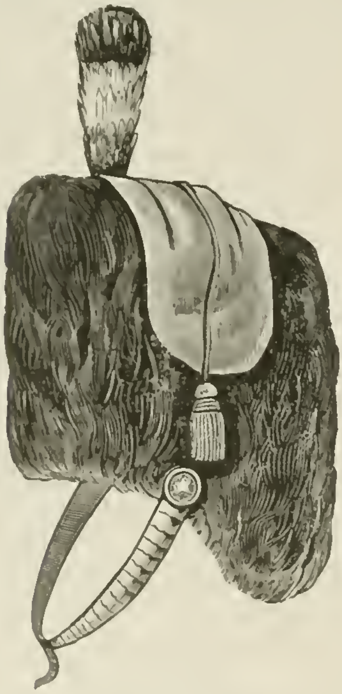
DRUG-CARRIAGE.—The truck-carriage used for moving heavy guns in positions where the size of the platform would be inconvenient. There are several sizes of drugs. The largest is constructed to carry heavy guns of the present day, and is fitted with two pairs of frame-shafts and outriggers for the swingle-trees for four horses abreast. The small and medium drugs are fitted for man-draught.

DRUM.—A hollow cylinder of wood or metal having skin (parchment) stretched across one or both ends, upon which the drummer beats with an instrument of wood or metal called a *drumstick*. The drum is used as an instrument of music along with other instruments in bands, and particularly for military purposes. The military drum serves for giving various signals as well as for music. There are three kinds of drum—the *snare* drum, the *double* or *base* drum, and the *kettle*-drum. Since 1858 the British infantry are supplied with brass snare-drums, 3 lbs. lighter than those formerly in use, and tuned with screws instead of straps and ropes. The cavalry-drum is a copper or brass hemisphere, thus resembling a *kettle*, with a parchment lid. The base-drum has both ends covered with parchment. The ancient Romans used small *hand*-drums—some resembling tambourines, others *kettle*-drums—in their religious dances; and the Parthians are said to have used them in war to give signals. They are believed to have been first brought into western Europe by the Crusaders. See *Base-drum, Kettle-drum*, and *Snare-drum*.

DRUM-HEAD COURT-MARTIAL.—A Court-Martial called suddenly by the Commanding Officer to try offenses committed on the line of march, and which demand an immediate example. This method is not resorted to in time of peace.

DRUM MAJOR.—The introduction of the Drum Major at the head of a band is comparatively of recent date—that is to say, with the ordinary band. Outside of the larger and more pretentious military and professional organizations, his duties and importance have been but little known until within the last few years. It is safe to say that when bands once understand the great improvement in appearance and deportment a few weeks' drill under an officer of this kind will give them, they will consider him a necessary appendage to their organization. Any person having ordinary ability, with practice and a little study, can master the more important points in a very short time, and take his position at the head of the band with credit to himself and associates. We append the directions for the giving, and how to execute, the most important signals. We cannot, of course, within the limits of this work, go into the details for elaborate drill; but what is given is sufficient for an ordinary street-parade, and, when thoroughly mastered, there can be easily added such fancy movements as the star, the cross, the triangle, the hollow square, etc., as may be desired.

The person selected for Drum Major should be of good military form, and, where possible, one who has had experience in military drill. He should have good time, though he need not necessarily be a musician. From the time the band leaves the band-room until return and dismissal, he is the ranking officer, and has full charge of the movements of the band. The leader selects the pieces he desires played, but awaits the proper signal from the Drum Major



Bear-skin of Drum Major.

"to play" and "to cease playing." As soon as one piece is finished the leader should immediately decide upon the next, and so inform the band, though it may not be required that it should be played for an hour; then, without confusion or unnecessary delay, all are in readiness when the signal "play" is given. Conversation in the ranks should be especially avoided, as it detracts attention from the Major, and soon leads to carelessness, which means crooked files, bad "wheels," and general deterioration.

The Drum Major's uniform should, if expedient, contrast somewhat with that of the band. The bear-skin hat of white or black, shown in the drawing, is the conventional emblem, after which the dress can be plain or elaborate, as the wearer may determine.

The position of the Drum Major is three yards in front of the band, opposite the center. The staff is held in the right hand below the chin, the back of the hand to the front, the head of the staff near the hand, the ferrule pointing upward and to the right. After each signal, unless keeping time for the band, the staff should be restored to its original position.

The following signals of the Drum Major must be promptly observed and obeyed:—*To play:* Face toward the music, and extend the right arm to its full length in the direction of the staff. *To cease playing:* Extend the right arm to its full length in the direction of the staff. *To march:* Turn the wrist and bring the staff to the front, the ferrule pointing upward and to the front; extend the arm to its full length in the direction of the staff. *To halt:* Reverse the staff and hold it horizontally above the head with both hands, the arms extended; lower the staff with both hands to a horizontal position at the height of the hips. *To countermarch:* Face to the band and give the signal to march. The countermarch is executed by the file-leaders to the right of the Drum Major wheeling individually about to the right; those to the left, to the left; the other men of each file follow their file-leaders. The Drum Major passes through the center. *To oblique:* Bring the staff to a horizontal position, the head opposite the neck, the ferrule pointing in the direction the oblique is to be made; extend the arm to its full length in the direction of the staff. *To march by the right flank:* Extend the arm to the right, the staff vertical, the ferrule upward, the back of the hand to the rear. *To march by the left flank:* Extend the arm to the left, the staff vertical, the ferrule upward, the back of the hand to the front. *To diminish front:* Let the ferrule fall into the left hand at the height of the eyes, the right hand at the height of the hip. *To increase front:* Let the ferrule fall into the left hand at the height of the hip, the right hand at the height of the neck. *The general:* Bring the staff to a vertical position, the hand opposite the neck, the back of the hand to the front, the ferrule pointing upward. *The assembly:* Bring the staff to a horizontal position, the hand opposite the neck, the back of the hand down, the ferrule pointing to the front. *To the color:* Bring the staff to a horizontal position at the height of the neck, the back of the hand to the rear, the ferrule pointing to the left.

In marching, the Drum Major beats the time with his staff and supports the left hand at the hip, fingers in front, thumb to the rear. The Drum Major, before making his report at parade, salutes by bringing his staff to a vertical position, the head of the staff up and opposite the left shoulder. The Drum Major marching in review passes the staff between the right arm and the body, the head to the front, and then salutes with the left hand. In executing *rear open order*, each rank of the band takes the distance of three yards from the rank next in front. When the field-music is by itself, the fifers are placed in front; in the field-music of a company, the fifer is on the right of the drummer.

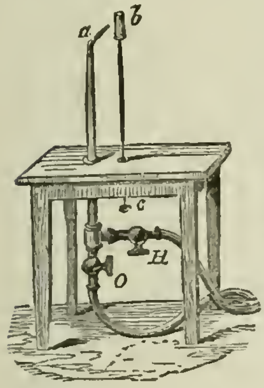
The Drum Major, when saluting, passes the staff between the right arm and the body, the head of the staff to the front; then bringing the left hand up smartly, pointing in the same direction as the left foot, the palm of the hand down, the thumb close to the forefinger, the arm horizontal; bringing the hand round till the side of the forefinger touches the lower edge of the cap over the left eye, at the same time turning the head a little to the right, looking toward the person to be saluted, and retaining the position till the salute is acknowledged; then bringing the hand back to the horizontal position, at the same time casting the eyes to the front; then dropping the hand quickly to the hip. See *Band.*

DRUM MAJOR GENERAL.—The Drum Major, as a component member of a regiment, was not much known in the English army till the time of Charles I. There was in earlier times an officer in the Royal Household called the *Drum Major General*, without whose license no one except Royal troops might use a drum; but this office fell into disuse. The Drum Major, when regularly established, received orders from the Major of the battalion concerning the necessary beats or signals, and communicated them to the drummers. The management of the big drum, and the teaching and control of the drummers generally, still devolve upon the Drum Major. The "beats" at present adopted by the British infantry were composed by Drum Major Potter of the Coldstream Guards. See *Drum Major*.

DRUMMER.—The soldier who plays a drum. The majority of drummers are boys, generally the sons of soldiers. The drummer is a component member of every British regiment. His position is slightly superior to that of the private soldier, but still he is reckoned as one of the rank and file. Besides his ordinary duties, the drummer performs the *drumming out* when a soldier is discharged with ignominy. To the drummers is also intrusted the repulsive duty of flogging, when that sentence is passed upon soldiers. A *Drum-head Court-Martial* (not now much adopted) has no particular connection with the drummers, but is a hasty Council or Court-Martial held in the field around the big drum.

DRUMMING OUT.—The ceremony of ignominiously discharging a soldier from the service. The culprit is marched out of the garrison at the point of the bayonet, the drummers or musicians playing the "Rogue's March."

DRUMMOND LIGHT.—The heat given out during the combustion of a mixture of hydrogen and oxygen gases, or of coal-gas and oxygen, is very intense; and when the mixture is directed on an infusible substance, such as lime, a most brilliant light is evolved. Captain Drummond, R.E., originally proposed the employment of this light in the trigonometrical survey of Great Britain, and constructed apparatus for its production. The most convenient form of the apparatus is represented in the figure, where the mixed gases escaping by the jet *a*, being set fire to and made to impinge upon the cylinder, *b*, of lime, raise the surface of the latter nearest the jet to a white heat, accompanied by a very dazzling light. As minute portions of lime become detached and are volatilized from the spot on the lime on which the jet of burning gases strikes, it is necessary to expose a new surface of lime to the gases, and for this purpose the screw, C, may be turned by the hand or by clockwork. The hydrogen and oxygen ought to be confined in separate gasholders or bags, and to be brought by different tubes, H and O, provided with separate stop-cocks, to within a short distance of the exit-jet. The common tube through which the mingled gases pass to the jet is to prevent the return of the flame, which might lead to a disastrous explosion. When the rays from this light are concentrated by a parabolic reflector, it can be seen at immense distances. Thus on the 31st December, 1845, at half past 3 P.M. (daylight), the light was exhibited on the top of Slieve Donard, in County Down, and was seen from the top of Snowdon, a distance of 108 miles; and in other instances the Drummond light has been seen at distances up to 112 miles. The employment of coal-gas instead of hydrogen has greatly increased the applications of the Drummond light, and it is now often used in magic-lanterns and other apparatus where great brilliancy and penetration of light are required. It has been used lately on the Continent with great effect in illuminations. Great caution should at all times be exercised in the preparation, storing, and employment of the gases, as many dangerous explosions have occurred. Little heat is evolved from the Drummond light, nor does it vitiate the surrounding air or consume its oxygen. See *Electric Light*.

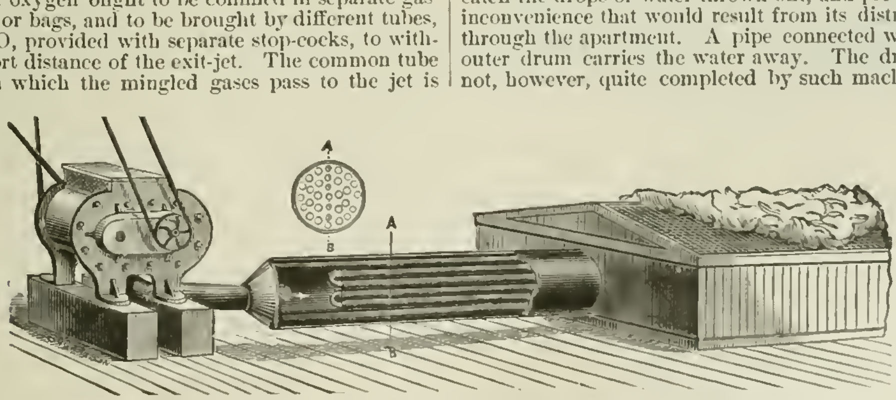


DRUMSTICK.—A stick with which a drum is beaten, or one shaped for the purpose of beating a drum.

DRUNK ON DUTY.—A crime severely and summarily punished in all services. In the United States, the Articles of War provide that any officer who is found drunk on his guard, party, or other duty shall be dismissed from the service. Any soldier who so offends shall suffer such (*corporal*) punishment as a Court-Martial may direct. No Court-Martial shall sentence any soldier to be branded, marked, or tattooed.

DRY CAMP.—Troops on the march are said *to make a dry camp* when they are compelled by exhaustion or other causes to camp at a place where there is no water. For such camps water is usually transported with the troops.

DRYING-MACHINES.—The ordinary processes of drying by exposure in the open air have been found too tedious for large establishments, and hot-air chambers have been extensively used; but a great improvement has been lately made by using the principle of centrifugal force to throw off the greater part of the moisture. The drying-machine commonly used in arsenals and laundries consists of two drums or cylinders open at the top; the inner one, into which the goods are packed, is perforated at its sides, and made to revolve with great velocity either by steam, water, or hand power. The action of the drying-machine is precisely the same in principle as that witnessed when the housemaid is *trundling* a mop, or of the dog when he shakes himself on coming out of the water. The use of the outer cylinder is merely to catch the drops of water thrown out, and prevent the inconvenience that would result from its distribution through the apartment. A pipe connected with this outer drum carries the water away. The drying is not, however, quite completed by such machines: a

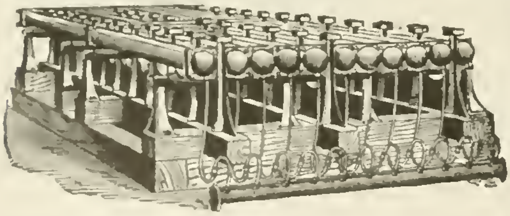


Drying-machine.

about six inches long by two thirds of an inch in diameter; and in Mr. Hemming's construction the tube is very closely packed full of very fine brass wire, which is afterwards wedged in by a stout wire being driven down the center. The object of the fine wires very slight degree of moisture, just perceptible to the touch if the goods are pressed against the cheek, still remains. This is expelled by open-air or hot-chamber drying. These drying-machines are commonly called "extractors." A simpler and cheaper drying-machine has been lately introduced for domestic use. It consists of two rollers mounted parallel, and one above the other, with an adjustment to vary the distances between them. One end of the article to be dried is inserted between the rollers, which are then brought as close as possible together, and one roller is turned by a handle; the other, being free to revolve, turns also as the clothes pass between them—the moisture in this case being extracted by pressure, as in the common process of "wringing."

For articles in bulk, such as wool, cotton, etc., the arrangement for drying shown in the drawing, has a number of advantages over others in use. The method for supplying and heating the air is simple and inexpensive, as compared with some others in which the heater is arranged on the plan of a tubular boiler with inside flues. The steam for heating is let into this boiler, and the air to be heated passes through the inside of the tubes. The heater must have the strength of a boiler, and the tubes secured in the same way, to bear the pressure of the steam. This is necessarily expensive; and the air passing through the inside of the tubes is brought in contact with only a small heating-surface. In the plan illustrated, a Roots' Positive Blower furnishes the blast, and the outside case or air-conductor needs only to be made of No. 18 galvanized iron. The air passes through this conductor, and is heated by steam passing through return-coils of ordinary gas-piping. This arrangement can be made at a small cost, as compared with the plan spoken of above, and is much better, as the air is brought in contact with from twenty-five to fifty per cent more heating surface by passing on the outside of the pipes instead of the inside. When, as in the former case, the air is forced through the inside of the pipes, considerable force or pressure is required to overcome the friction, which is only effected at the expense of considerable power; while, in the plan shown above, a large and ample space is given for the passage of the air.

DRYING-STOVE.—An apparatus employed in the manufacture of gunpowder. It is simply a close chamber heated to a high temperature by steam; the doors and windows of the building are double, so as to prevent the loss of heat, and the interior is fitted up with an open framework of wood, supporting trays upon which the powder is spread out to dry. A series of cast-iron steam-pipes consisting of twenty-two lengths, each about 11 feet long, with an ex-



Drying-stove.

ternal diameter of 7½ inches, are laid a few inches above the floor; these pipes are arranged horizontally, with an inclination or fall of 1 inch in 11 feet from the end where they are connected to the main steam supply-pipe, which pipe is in direct communication with the steam boiler, the quantity and supply of steam being regulated by means of a stop-valve on the boiler. As the steam condenses—which it will do to some extent in the large pipes—the water runs off through a small wrought-iron pipe attached to the ends of the large ones; these drain-pipes are bent in such a form as to allow for the expansion and contraction of the large pipes, each length of which is supported on four rollers fitted into cast-iron brackets, for allowing a freedom of motion laterally. The small wrought-iron pipes conduct the distilled water formed by the condensed steam into a main cast-iron pipe which conveys it into a close tank, whence it is pumped into casks and taken to the incorporating-mills, where it is of much value for damping the charges. The drying-stove is about 32 feet in length by 30 feet in width, and from 10 feet to 11 feet in height, and affords about 10 cubic feet of space to every square foot of heating surface. A wooden staging is erected immediately over the pipes, for supporting the trays; these trays consist of wooden frames with canvas bottoms, each being 3 feet in length by 2 feet 6 inches in width, and about 1¼ inch deep, and upon each of these from 6 pounds to 8 pounds of gunpowder are spread out evenly upon the canvas bottom. The stove contains 256 trays, consequently from 30 to 40 barrels of powder can be dried at one time. It requires about four hours to heat the drying-stove up to a temperature of 130° F., to which heat the powder is subjected. The temperature can always be ascertained by the attendant without opening or entering the drying-stove, as a large thermometer is placed inside the building, at the window, with its face outwards. After the powder has been subjected to the full heat for a period of from sixteen to eighteen hours, the steam stop-valve on the boiler is closed, and the chamber allowed to cool down. In from two to three hours the temperature is sufficiently reduced to admit of the attendant entering for the purpose of removing the trays. It will therefore be seen that by this means one stove is capable of drying a full charge every twenty-four hours; but where the factory is large the better plan is to have two such stoves, with the steam-boiler placed between them, and to work each one alternately. It is of the utmost importance that the heat be applied slowly, otherwise the texture or shape of the grain is apt to change by being cracked or burst into pieces, and consequently spoiled. If the moisture is not carried away as it arises it will settle on the powder, and thereby injure the surface of the grain; to obviate this the roof and also the bottom of the drying-stove are provided with ventilators, and through these all the moist air escapes. These ventilators can, if necessary, be opened from the outside. When no more vapor arises the ventilators are closed, and the powder subjected to the full effect of the hot dry air for some few hours before the doors of the stove are opened. The action of the heat in drying the powder produces a small quantity of dust, consequently the powder has to be taken back to the dusting house, and there passed through a dusting-reel. The large-grain powder is put into a horizontal reel, covered with canvas having twenty-four meshes to the inch, and reeled for half an hour, which effectually cleans it, removing all the dust and giving to the powder a fine finished gloss. The fine-grain powder is run through a slope-reel, covered with canvas having twenty-eight meshes to the inch, and reeled for about two hours, after which it—as well as the large-grain powder—is put into casks provided with copper or ash hoops, and when closed the heads of the casks are branded according to the size and nature of the powder contained in them. This completes the manufacture, and the gunpowder is now ready for use or storage as may be required. In a given quantity of "mill-cake" the proportions obtained are as follows: about seven tenths large-grain, two tenths fine-grain, and one tenth dust; in damp weather, however, these proportions are somewhat altered, the dust during such weather being considerably increased. See *Gunpowder*.

DRY PROCESS.—The collodionized glass plate, on being withdrawn from the bath, previous to and during exposure in the camera, has mechanically adhering to its surface a quantity of solution of free nitrate of silver, and it is partly upon the presence of this salt that the extreme sensitiveness of wet collodion plates depends. This, however, is not the sole cause of sensibility to actinic rays; carefully conducted experiments fairly lead to the assumption that the molecular arrangement of the ultimate particles of iodide of silver, and of the pyroxyline, forming, as it were, the network of the film while wet, materially affect this necessary condition; and it is the object of what is termed a *dry process* to preserve this molecular arrangement as far as possible unaltered, notwithstanding the disturbing influences which would necessarily be exerted by the desiccation of the film. This desirable end for military photography is accomplished with more or less certainty by the employment of solutions of various substances, which are poured over the film after the adhering nitrate of silver has been removed by copious washing with water. The heterogeneous character of the substances so used goes far to prove that their action is principally *mechanical*, they being selected from the animal, vegetable, and mineral kingdoms. Among the first may be mentioned honey, gelatine, glycerine, milk, and albumen; among the second, syrups, gum, wine, beer, balsams, and resins added to the collodion, and linseed tea; and among the third, chloride of calcium, nitrate of zinc, and nitrate of magnesia. The plate, on its removal from the sensitizing bath, being well washed with water, any one of these substances is dissolved in water in suitable proportion, and applied to the surface of the plate by pouring on and off several times. It is then set up to drain and dry on folds of bibulous paper in a dark closet or box. The plate is then ready for use. The pictures obtained on plates so prepared do not suffer by comparison with those taken by the wet collodion process; the only drawback to their use being a slight diminution in the degree of sensibility to light. See *Photography*.

DUALINE.—An explosive composition of nitro-glycerine, fine sawdust, and nitrate of potassa (in proportion of 50, 30, and 20 parts), intended to diminish the danger in the transportation and storage of nitro-glycerine. Compared with dynamite, it is—1. More sensitive to heat, and also to mechanical disturbances, especially when frozen, when it may even be exploded by friction; 2. The sawdust in it has little affinity for the nitro-glycerine, and at best will hold but 40 to 50 per cent of nitro-glycerine, and on this account very strong wrappers are needed for the cartridges; 3. Its specific gravity is 1.02, which is 50 per cent less than that of dynamite, and as nitro-glycerine has the same explosive power in each, its explosive power is 50 per cent less than that of dynamite; 4. The gases from explosions, in consequence of the dualine containing an excess of carbon, contain carbonic oxide and other noxious gases. Lithofracteur and dualine, however, can be exploded, when frozen, by means of an ordinary fulminating-cap, which is not the case with dynamite. Dualine was invented soon after dynamite. The patent describes it as consisting of "cellulose, nitro-cellulose, nitro-starch, nitro-mannite, and nitro-glycerine, mixed in different combinations, depending on the degree of strength desired in adapting its use to various purposes." A sample supplied by the inventor, Carl Dittmar, for trial at the Hoosac Tunnel, was found by analysis to consist of 60 per cent of nitro-glycerine and 40 per cent of washed sawdust, not treated with nitric and sulphuric acids. The best variety now manufactured is believed to be cellulose derived from poplar pulp, treated with nitric and sulphuric acids, and saturated with nitro-glycerine. When soaked in water it can be exploded only by a violent detonation, exceeding that of the ordinary fuse, and even then it loses more than half its power. It congeals at about 45 Fahrenheit, and in this state readily explodes, becoming so sensitive to friction as to make it dangerous to use in cold weather. In other respects its properties resemble those of dynamite. See *Dynamite, Explosive Agents*, and *Nitro-glycerine*.

DUCENARIUS.—The title of an officer in the Roman armies who commanded two Centuries.

DUCTILIMETER.—An instrument invented by M. Regnier for ascertaining the relative ductility of metals. The metal to be tested is subjected to the action of blows from a mass of iron of given weight attached to a lever, and the effect produced is shown upon a graduated arc.

DUEL.—A combat between two persons, at a time and place indicated in the challenge, cartel, or defiance borne by one party to the other. A duel generally takes place in the presence of witnesses, called seconds, who regulate the mode of fighting, place the weapons in the hands of the combatants, and enforce compliance with the rules which they have laid down.

No trace of the duel, as an institution, is to be found in the history of the classical nations of antiquity, the Latin word from which ours is derived having been used to signify a war between two nations. So long as men continued to be barbarians their personal quarrels were no doubt decided in the ancient, as national quarrels still are in the modern world, by an appeal to physical force. But though war has been in all times the practical solution of strife, it was not till the Middle Ages that it came to be regarded as a means, in any sense judicial, of settling disputes. Hitherto it had determined who was able to prevail, justice being set aside, but it was a new view that it would determine who ought to prevail on the principles of justice. The rationale of the *judicial combat* or wager of battle was probably twofold. On the one hand, and generally amongst the people, it depended on a belief that God would interfere directly and miraculously in the conflict to protect the innocent and to punish the guilty, and that thus the weakest combatant who had God on his side would prove more than a match for the strongest when destitute of his aid. But there was a view of the matter which was not so directly superstitious, and which rested rather on a confusion between the principle of the original constitution and the principle of the transmission of rights. All human rights originate in the powers and faculties which God has given to man, and it was supposed that as the right originated in power, its continued existence in the individual could be ascertained by ascertaining whether the power still existed in him. The error consisted, as we have said, in confounding the principle of the constitution with the principle of the transmission of rights. If a field which was claimed by two competitors had as yet been appropriated to nobody, or had been abandoned, and was, as lawyers say, *res nullius*, the fact which of the two claimants ought to become the possessor might be ascertained by judicial combat. But if it was already the property of one of them on a title which was to be held sacred, and the question was which of the two had this sacred title, that fact could never be determined by ascertaining which would have been in a condition to constitute it for the first time, had it been non-existent. The principle of the private duel, in so far as it had any principle at all, and was not merely a piece of barbarous and irrational foppery, was precisely the same as that of the judicial combat. But the latter had been applied to a class of cases which admitted of legal investigation and decision, and it was consequently abandoned in the days of Queen Elizabeth; whereas the former was supposed to be a means of redressing wrongs which hardly can come within the cognizance of a human tribunal, and the consequence was that it continued in green observance in England until recently, and is still in vigor in many Continental countries.

Like the other peculiarities of mediæval life, the duel probably originated with the Germanic nations. It is said to have been introduced into legal proceedings in lieu of an oath by Gundebald, King of the Burgundians, in 501. Louis le Débonnaire was the first of the French kings who permitted litigants to appeal to arms. The practice was prohibited by Henry II., in consequence of a noted duel which took place in his presence between his friend Francis de la Chastaigneric and Guy Chabot de Jarnac, in which the latter was slain. The royal edict, however, was totally ineffectual, and the practice of private dueling has generally prevailed more extensively in France than in any other country. Francis I patronized it by declaring that a lie could be borne without satisfaction only by a base-born churl, and still more by the example which he set in challenging his own great rival Charles V. In 1599 the Parliament of Paris declared all persons who were either principals or seconds in duels to be rebels to the King. But its efforts were unavailing; and it is said that during the first 18 years of Henry IV. no fewer than 4000 gentlemen perished in this foolish manner. In 1609 Henry added to the existing penalties, introducing even punishment by death in extreme cases. But these regulations were forced upon him by popular feeling; he had himself no aversion to the practice, and when he gave permission to Crequi to fight Don Philip of Savoy, he added: "If I were not the king, I would be your second." The consequence of this feeling was that he readily granted pardons to those who had violated the laws which he had been forced to enact, and these laws not unnaturally produced an effect the very reverse of their ostensible object. Duelling acquired the charm of what the French call "forbidden fruit," and thus became a fashionable and favorite vice. In the reign of Louis XIII. the custom was so prevalent that Lord Herbert, the English Ambassador, wrote home to his Court that there was scarcely a Frenchman worth looking on who had not killed his man. It would not seem, however, that it was from negligence in enforcing the royal edicts that duelling then reached to so alarming a height; for it was during this reign that two noblemen, the greatest duelists of the day, the Count de Boutteville and the Marquis de Beuron, were tried and beheaded for persisting to fight. In the commencement of the reign of Louis XIV., duels with four or five a side began to be fought; and two very sanguinary affairs of this description having taken place, in which several persons of the highest rank were slain, the King determined to put an end to the practice. He published an edict in 1679 forbidding it under the highest penalties, which, unlike most of his predecessors, he had the firmness to inflict; and this measure, together with a solemn agreement which was entered into amongst the nobility themselves, led at that time to its almost total abolition.

The duel does not seem to have existed in England in Anglo-Saxon times, and was probably introduced at the Conquest. In its judicial form it was not totally obsolete in the reign of Queen Elizabeth; and Sir Henry Spelman gives an account of a Trial by Battle, which terminated, however, without actual combat, in the year 1571. Private dueling was common, however, both in Elizabeth's reign and in that of her successor, by whom a severe statute against it was enacted in Scotland. During the civil wars men's minds were too much occupied with questions of grave importance to leave time for questions of etiquette, and the duel consequently declined; but it became exceedingly prevalent during the dissolute reign of Charles II. Some attempts were made to suppress it in the reign of William III., both in England and Scotland, and in 1712 the subject was recommended to the attention of Parliament in the Queen's speech. But the bill which was brought in by the Government was thrown out, and the practice continued to prevail. When the custom of wearing the sword was abandoned, the number of duels diminished, though it was then that their irrational character may be said to have attained its maximum. The pistol was substituted for the sword, and the doctrine of chance—which was reduced to an absurdity by the medical duel of a couple of pills, one composed of bread and the other of poison—was inaugurated. Since this period the practice has fallen into disrepute, by the gradual operation of public opinion, and in Great Britain it may probably be now regarded as finally abolished. The duels of the students at the German universities, of which so much has been said and written in this country, are nothing more than fencing-matches with sharp weapons. They are foolish but not deadly affairs, as the seconds, who are also armed, always interfere to prevent serious bloodshed.

In the southern portion of the United States the custom of dueling, though of late years falling into disuse, is a recognized institution of society. Half a century ago the pistol and the bowie-knife were as much a part of a man's equipage as his hat or his boots. A gentleman of good social position who had not fought at least one duel was often looked upon as deficient in the qualities proper to his station. Sudden affrays in the streets, stealthy assassinations, and bitter family feuds, were the consequences. These feuds rivaled in duration and ferocity the Venetian vendetta. The land was full of swaggering bullies who had, metaphorically, in one hand a pack of cards and in the other a pistol. Modern civilization, and more especially the War of the Rebellion, in which the Southern States suffered so terribly, have greatly modified this fire-eating spirit. Other influences have assisted. Not only is the general voice against the practice, but in a large number of the States laws have been enacted which pronounce the killing of a fellow-being in a duel to be murder, and in still more States the mere sending of a challenge is a felony. A person in the military or naval service implicated in a duel, either as principal or second, may be summarily cashiered. In some of the States the killing of a man in a duel is punishable with death; in others by imprisonment and forfeiture of political rights. In some States certain officers are required to swear that they have not been, within a certain period, and will not be, engaged in a duel. See *Articles of War*, 26, 27, and 28; *Challenge*, 2; and *Wager of Battle.*

DUFFADAR.—In the native East Indian cavalry, a non-commissioned officer corresponding with the rank of Sergeant.

DUFFADAR MAJOR.—A rank in the Indian cavalry corresponding with the Sergeant Major of a European regiment of cavalry. See *Kot Duffadar.*

DUFOUR BASTION SYSTEM.—The enceinte is traced as in the modern system; the ditch is 30 yards wide at the salient of the bastion, and the counterscarp is directed on the shoulder-angle. A *cavalier*, or bonnet, 24 feet high, is erected at the salient of the ravelin. The parapet of the cavalier is only 4 yards thick, and is supposed to be sufficiently strong to resist ricochet; there is no rampart; the banquette is destined for musketry, and its slopes descend to the terre-plein of the ravelin. The ravelin is 22 yards wide, with ramps 3 yards wide and slope $\frac{1}{10}$. The *reduit of ravelin* is separated from the ravelin by a ditch 10 yards wide and 6 yards deep, its bottom being 6 feet above that of ravelin and 12 feet above the main ditch. The reduit has a command of 6 feet over the ravelin at the salient and 1½ feet at the rear, so that its plane of defilade passes above the lodgment of the cavalier. The covered-way is 10 yards wide, and has four traverses. This system possesses many advantages, with but few serious faults. The cavalier prevents the defenders from placing artillery at the salient of the ravelin, where its presence is so important, and the reduit of the ravelin has no room for guns. See *Fortification.*

DUKE.—A term applied originally to any military leader. Gibbon informs us that the title came first into use when Constantine separated the civil and the military commands in the Provinces, which had been exercised in common by such men as Agricola. From that time forth, the Military Governors of Provinces were either Counts or Dukes. But these titles originally stood to each other in an opposite relation to that which they afterwards assumed. "It should be recollected," says Gibbon, "that the second of these appellations—that of Duke—is only a corruption of the Latin word which was indiscriminately applied to any Military Chief. All Provincial Generals were therefore *Dukes*, but no more than ten among them were dignified with the rank of *Counts*, or Companions, a title of honor, or rather of favor, which had been recently invented in the Court of Constantine." "A gold belt," continues Gibbon, "was the ensign which distinguished the office of the Counts and Dukes; and, besides their pay, they received a liberal allowance, sufficient to maintain 190 servants and 158 horses. They were strictly prohibited from interfering in any matter which related to the administration of justice or the revenue; and the command which they exercised over the troops of their department was independent of the authority of the Magistrates." When the Goths, and Franks, and other barbarians successfully invaded the Provinces of the Empire, they preserved the titles of Count and Duke, if they had not already borrowed them from the Romans. But amongst races who owed their supremacy to the sword no dignity could prevail over that of the Commander of an Army; and the Dukes, as Military Chiefs, acquired a marked pre-eminence over the Counts, whose lofty functions under the Empire had been partly of a civil and partly of a military nature. The only exception under the first Merovingians was in the case of the Count of the Palace. In the hierarchy observed by the Franks and other Teutonic races, the ordinary Count became the Lieutenant of the Duke, and the government of the latter extended to several Provinces; whereas that of the former was confined to one Province, or even to a single locality. The power of the Dukes grew so rapidly, in consequence of the dissensions of the Merovingians, that, towards the end of the sixth century (582), they arrogated to themselves the right to dispose of the Crown. Amongst the causes which tended to raise the power of the Dukes was the immense wealth which had been acquired by the great provincial families. The Chiefs who had attached themselves to the fortunes of Clovis had been richly endowed with conquered lands. After the close of the seventh century they overshadowed the Crown, and the title of Prince and Chief (*Chef*) began to be attributed to them. It has been said that the *Ducs-maires* of the Palace sometimes assumed the title of Archduke. Under the Second Dynasty the title of Duke retained all its dignity and importance, and it was to the successive invasions of local upon central power that feudality owed its origin.

DUKE OF YORK'S SCHOOL.—The popular designation for the *Royal Military Asylum* at Chelsea. In the French army there have long been *Enfans de Troupe* borne on the books of each company or battalion of soldiers; that is, children of deceased soldiers, unprovided with other homes. In England no such system prevails. The late Duke of York, in the year 1801, used his influence to obtain the formation of a Soldiers' Orphan Asylum. Accommodation was obtained at Chelsea; and in 1803 schools were opened for 700 boys and 300 girls, children of deceased soldiers. The Institution has been kept up ever since for the boys, of whom 500 are now maintained, but was a failure as to the girls. The boys are wholly supported as well as educated. They are not bound to serve the State after they leave the Asylum; but most of them nevertheless enter the army. A soldier's son has not a *right* of admission; a selection is made according as vacancies may occur. When the boys leave the School, those who do not enter the army are apprenticed to trades. The Asylum is under a Board of Commissioners, who make the necessary rules and regulations. The chief officers are the Commandant, Secretary, Quartermaster, Head-master, Chaplain, Surgeon, and Dispenser. The expenses are defrayed by an annual Parliamentary grant, included in the army estimates. No provision is now made by the State for the *daughters* of deceased soldiers. The girls admitted into the Asylum in the early years of its history brought discredit to it by their after-life; and this part of the system was abandoned. There is only a Royal Patriotic Fund Asylum on Wandsworth Common, unaided by the State, for soldiers' orphan daughters; it originated during the Crimean War.

DUKIGI-BACHI.—The Second Officer in the Turkish artillery, who commands the Topelas, or gunners and founders.

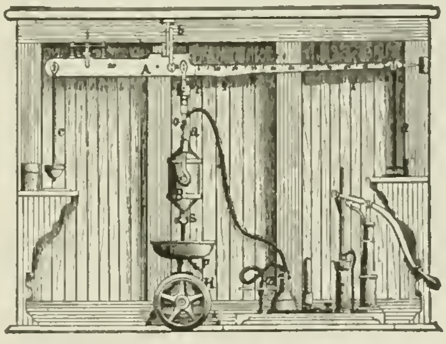
DULEDGE.—A peg of wood which joins the ends of the felloes forming the circle of the wheel of a gun-carriage; the joint is strengthened on the outside of the wheel by a strong plate of iron, called the *duledge-plate*.

DUMMY FRICTION-TUBE.—A non-ignitible tube which is used for drill purposes. It consists of a steel prong, fork, and lanyard; the prong is entered in the fork, which is inserted in the vent and pulled through by the same motion which fires the service friction-tube. Since the original pattern was approved of it has been found that the prongs are liable to fracture the "eye." In the present pattern the prong is made stronger, and the split of the spring is carried through its neck, instead of the latter being solid.

DUMPY LEVEL.—A leveling instrument for short distances. It has a short telescope with a very large field, and the compass is fixed underneath.

DUNDAS GUNS.—Smooth-bore guns of somewhat similar form to those of Mr. Monk's, and introduced into the English service some years ago by Colonel Dundas, R.A. They are not so conical, having a greater thickness of metal in the first and second reinforces. His 68-pdr. (95 cwt.) is used both as a land- and sea-service gun, and his 32-pdr. of 58 cwt. has been largely used in the Navy. There are other guns still in the service bearing his name, which are used for land or sea purposes.

DUPONT DE NEMOURS DENSIMETER.—A mercury densimeter, adapted, by its construction, to the reception of large grains, and having capacity for five pounds of powder, which, for convenience, is the weight of sample always employed. It differs, however, from the small densimeter in ordinary use by a combination of the different parts, such that the reservoir for containing the powder and mercury to be weighed, and the balance by means of which the weighings are made, are assembled together in one instrument. The balance also is so adapted to its special purpose as to simplify considerably the subsequent process of calculation. A great saving of labor and time is gained by this form of the instrument, and the occurrence of breaks and leaks, so frequent in the smaller ones, is in great measure avoided. Again, from the much larger sample of powder employed, a fair representative result of the specific gravity of the entire lot is more likely to be secured.



Dupont De Nemours Instrument.

To describe more particularly, the instrument consists of three principal parts, to wit: A beam-scale, A, a reservoir, B, to contain the powder and mercury to be weighed, and a bowl, C, to contain mercury alone. In connection therewith, an air-pump is employed, the cylinder of which has communication with the interior of the reservoir through a rubber tube leading from the nozzle of the pump to the glass tube, *a*, at the top of the reservoir. The balance is suspended from a hook, *b*, firmly secured to the roof of the housing, and its axis of suspension is a knife-edge lying in the same plane with the axes of suspension of the rods *c* and *d* and of the reservoir B. Platforms are attached to the suspension-rods *c* and *d*, on which to place the weights. The latter consist of pounds, tenths of a pound, and five-hundredths of a pound, marked in reference to the weights they will balance in the reservoir, and of a large unmarked weight, W, termed the "counterpoise." This counterpoise has a cavity bored in it lengthwise; its weight is about eight pounds. The long arm of the beam is also graduated, and by means of "riders," or sliding weights, the weighings can be made to hundredths and thousandths of a pound; the graduated edge of the beam is in the same plane with the knife-edges. There are two counterpoises admitting of movement on screw-spindles passing through them, in directions that are respectively parallel and perpendicular to the beam. The former is used to adjust the arms to the same weight, the latter to regulate the sensibility of the beam. In connection with one counterpoise a light wire is sometimes used along the beam to facilitate the adjustment of the arms. The beam and its appurtenances proper are of brass. The reservoir B is of cast-iron and swings on trunnions in a yoke. It also admits of a horizontal angular movement about a vertical pivot connecting the yoke with a suspension-stirrup. A screw-cap, fitted with a leather washer, covers the mouth of the reservoir, and when removed, for the purpose of introducing powder, is attached to a hook on the outside of the yoke, so as to be included in the weighing. The mercury is admitted or withdrawn through the stop-cock *s*. The conical ends of the reservoir are cast in separate pieces and are afterwards screwed on to the cylinder, the joints being well leaded. Careful workmanship is requisite to prevent the formation of a ledge or recess at these joints, which might serve to retain sufficient portions of the mercury to affect the accuracy of the subsequent weighings. The diaphragms of wire and of leather usually employed to cover respectively the upper and lower apertures of the reservoir are not required in this instrument. The capacity of the reservoir is about seventy-eight pounds of mercury, or forty pounds of mercury and five pounds of powder. The mouth is 2¼ inches in diameter, and the sample of powder fills the reservoir to about the top of the cylindrical portion. The weight of the reservoir is twenty and a half pounds. The bowl C is of cast-iron, and by means of the crank H can be raised or lowered vertically. An outlet-pipe, *p*, at the bottom of the bowl, and furnished with a stop-cock, permits of the discharge of the mercury when desired. The air-pump is one in which, the cylinder remaining stationary, the oscillation takes place in the connecting-rod, which communicates the motion of the handle to the piston-rod.

To use the instrument, the beam is first accurately balanced by means of a counterpoise, when the bowl filled with mercury is run up till the nozzle of the reservoir is well immersed below the surface. The large counterpoise W is then placed on the platform suspended from the shorter arm, the rubber hose slipped over the top of the glass tube of the reservoir, the air exhausted by means of the pump, and the stop-cock *s* opened to admit the mercury. The pumping is continued during the ingress of the mercury, and when the latter has risen to a fixed mark, indicated on the glass tube, the stop-cock is closed and the rubber hose removed. Usually it is necessary to run off a little of the mercury and lower its upper surface to the fixed mark. The balance of the beam is now restored by dropping fine shot into the cavity of the counterpoise W, the weight of the latter being slightly less than the weight of the filled reservoir; this done, the stop-cock *s* is opened and the reservoir emptied. The counterpoise W is then replaced by the 5-pound weight, the screw-cap removed and hooked to the yoke, and a sufficient quantity of the powder to be tested introduced into the reservoir to balance the 5-pound weight. The screw-cap is then replaced, the counterpoise W added to the 5-pound weight, and the reservoir filled with mercury by means of the air-pump to the same height as before. The equipoise is now restored (the rubber tube having been removed) by placing weights on the platform suspended from the longer arm of the beam, and in addition by the "riders" on the beam if necessary. The sum of these weights is the weight of the mercury displaced by the powder, or of a volume of mercury equal to the volume of the powder, and the specific gravity of the latter results from the well-established principle that the specific gravities of two substances are proportional to the weights of equal volumes of those substances. Denote the sum of the weights on the longer arm by W′, the weight of the powder by *w*, and the specific gravity of the mercury at the temperature of the time of observation by D, and we shall have for the specific gravity of the powder, denoted by *d*;

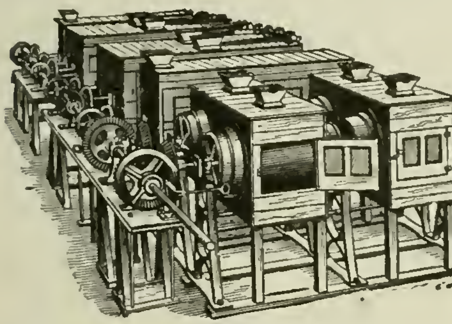
$$d = D\frac{w}{W'}.$$

In the use of this form of the densimeter the weighings not only are rapidly and accurately made, but, it is to be observed, the actual weights required for the computation are obtained directly by a discriminative process peculiar to the balance. To simplify further, the weights for the longer arm are marked double their actual value in reference to the reservoir, so that in the computation the specific gravity is obtained by setting the decimal-point in the value of D one place further to the right, and dividing by the value of W′, as indicated on the weights, the effect being the same as multiplying by 2 both terms of the fraction $\frac{w}{W'}$. See *Densimeter, Inspection of Powder*, and *Mercury Densimeter*.

DURER SYSTEM OF FORTIFICATION.—This fortification consists of a wall, flanked by circular towers or bastions, and a ditch 200 feet wide. The towers are of very different tracings, usually 70 feet high and command the enceinte. The wall of the enceinte is double; the top is provided with loop-holes and is covered with a roof. The great dimensions, together with the immense cost of masonry, render this plan practicably useless. See *Fortification*.

DUSACK.—A Bohemian saber of a peculiar shape, without a handle or a hilt. It was wielded with a gauntlet protecting the hand.

DUSTING-REELS.—The large-grain powder, removed from the granulating-house, is called "foul grain," owing to its containing a large percentage of dust that has been produced under the granulating process, for, although a great deal of it is removed from the powder by means of the lower long sixteen-mesh screen attached to the granulating-machine, still the powder contains a considerable quantity, and the object of passing it through the dusting-reels is to entirely remove what remains, and at the same time to rub down the rough, uneven surfaces of the grain, and thus prevent its becoming dusty again through moving it about in course of transport, for dust in gunpowder is very injurious, as it absorbs moisture from the atmosphere very readily, and this soon affects the whole mass. The dust is removed from large-grain powder by means of horizontal reels: these are cylindrical wooden skeletons, supported upon a central shaft by radial arms, the periphery of the cylinder being covered with canvas having twenty-four meshes per inch. The reel is about 8 feet long by 2 feet 6 inches in diameter; the wooden skeleton is made in halves, so that it may be easily removed for recovering. The ends are closed by disks, secured upon the main central shaft, and one end is so constructed that it can be opened or drawn back for the purpose of unloading the reel. When about to be filled, the reel is turned round until the charging-door is directly under the feeding-hopper; into this latter three barrels of foul grain are emptied, and when it has all passed through the hopper, the door of the reel is closed and fastened, the reel set to work at from 40 to 42 revolutions per minute, and kept in motion for about half an hour; at the end of this time it will be found that the whole of the dust will have passed through the meshes of the canvas covering, and will be lying at the bottom of the outer woodwork casing in which the reel is inclosed, in order to prevent the dust spreading over the house. When a number of reels are used, they are all driven from one main shaft which receives its motion from the water-wheel or steam-engine, and each reel is provided with a separate clutch, so that any one may be stopped or set in motion without affecting the others. When the reel has run the requisite time, it is stopped and the one end lowered about 10 inches, the disk at the lower end is slackened back sufficiently to allow the powder to run out into barrels, which it will do when the reel is again set in motion; when quite empty, the disk is again screwed tightly up to the end, and the reel raised to its horizontal position ready for refilling. By this operation the dust is not only taken from the powder, but the grain—from being rolled over for such a time—has its rough surfaces rubbed off, and in the case of large-grain powder a sufficient gloss is imparted without its



Dusting-reels.

having to be passed through the glazing-barrels. The powder is now ready for the drying-stove. The fine-grain powder used for rifles or small-arms has a much larger proportion of dust in it than the large-grain powder, and is therefore dusted in what is termed a "slope-reel," which consists—as in other reels—of a skeleton frame of wood fixed by radial arms on a central shaft, and lies at an incline of 1¼ inch per foot; the covering of this frame is of very fine canvas having forty-four meshes per inch, and the reel in this case has no ends; it is also much smaller than the horizontal reel, being only 20 inches in diameter by 8 feet in length, and is driven at 38 revolutions per minute. The fine-grain powder, as it leaves the granulating-machine, is brought from the magazine and placed in the feeding-hopper, to which is fixed a loose spout for guiding the powder into the reel. Attached to the central shaft are three ribs or cams which—as the reel revolves—come in contact with and shake the loose guiding-spout, imparting to it 135 vibrations per minute, thereby effectually keeping it clear, the fine-grain powder at this stage being very apt to choke up the hopper and spout. As the powder passes through the reel when in motion it is collected in a tub placed for its reception at the lower end; from this it is emptied back again into the hopper, in order that it may be passed through the reel a second time, and this operation is sometimes performed a third time. The fine grain thus treated, being only about one minute in the reel, has had no gloss imparted to it; the glazing has, therefore, to be effected by passing it through a glazing-barrel before it is carried to the drying-stove. See *Gunpowder*.

DUST-SHOT.—The name usually applied to small shot when used for military purposes; strictly speaking, the term implies the smallest size of shot made.

DUTCH OVEN.—A *camp-oven* used for cooking by hot coals on the hearth. A mode yet common in the field, and unsurpassed in its results with skillful cooks. The oven stands in hot embers, and more of the same are piled on the dish shaped lid.

DUTY.—There is no word oftener used in military parlance than this. In the technical sense it refers to the various services necessary for the maintenance, discipline, and regulation of armies,—as *signal duty*, *staff duty*, *guard duty*, etc. Military duties are variously classed as *duties of detail*, which are those recurring and governed by a roster, such as guard, fatigue, etc.; *special duties*, which are determined by appointment, selection, or order; *extra duty*, continuous special duty of enlisted men, entitling them to pay; *daily duty*, short terms of special service for enlisted men. In a higher and broader sense duty is that which is due one's Country. It covers all the soldier's obligations, and forms his simplest and sublimest rule of action. What is termed the "tour of duty" is invariably from the senior downwards. An officer on one duty cannot be ordered for any other until he has completed the duty on which he is engaged. If an officer's turn for Picket, General Court-Martial, or Fatigue happens when he is upon any other duty, he is not obliged to make good these services when he is relieved, but his tour passes him; however, if an officer is on the Inlying Picket, he is liable to be relieved and placed on other duties. Officers cannot exchange their duties without permission of the Commanding Officer. A guard, detachment, or picket having once marched off the place of parade is reckoned to have performed a duty, though it may have been dismissed immediately afterwards. Officers, on all duties under arms, are to have their swords drawn, without waiting for any word of command for that purpose.

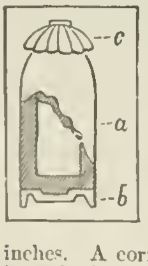
DUUMVIRS.—The officers among the Romans appointed for special services, such as Magistrates of Colonies and Towns, Constructors and Commanders of Fleets and Trains, and Municipal Censors. In the Eastern Empire the people elected for one year *duumviri ludorum*, who were to provide exhibitions of games at their own expense.

DWARF-PLATFORM.—A frame of wrought-iron from which heavy guns are fired when in open batteries. The original pattern is similar in general construction to the "common traversing" platform, and guns mounted upon this nature of platform can fire through ordinary embrasures. By lengthening the legs of a platform of this kind the gun could be fired over a parapet, if required. The ordinary garrison-carriage is used with it, but has blocks instead of axletrees upon which it rests, the part of the block between the cheeks being deeper, and passing between them, so as to keep the carriage in its place. In front of each bracket there is a pair of check-plates, in which a gun-metal truck works, which comes into play when the rear of the carriage is hoisted up by the truck-levers. The carriage is run up by means of tackles. Dwarf-platforms were made to traverse on a pivot, but "raised racers" have been substituted, the platform resting on hollow solid trucks which run upon the racer. Since the introduction of heavy rifled artillery a change of pattern has taken place not only in this nature of platform, but in the carriage adapted to it, which is of the ordinary *single* or *double plate pattern*, both of which are made of wrought-iron. Casemate carriages and platforms are similarly constructed, and the platforms of each only differ in the height they are raised from the ground; the casemate-platform being low for use in casemates, and the dwarf-platform high for open batteries.

DYER POINTING-APPARATUS.—This method of pointing, devised by Lieutenant A. B. Dyer, United States Army, is especially adapted for use with mortars mounted on center-pintle carriages; it is also readily adapted for use with mortars mounted on ordinary and temporary platforms. Practically it is independent of the distance from the crest of the parapet to the platform. The method is as follows: Find the point where the vertical plane containing the directrix of the platform cuts the interior crest of the parapet. At this point establish a level plate containing an arc graduated both ways from the point where the vertical plane cuts it, the center being the point first established on the interior crest. An arm with two vertical sights revolves about this point as a center, and determines, by means of an indicator attached to the front of the arm, the angle made by any object with the vertical plane through the center, called the plane of the zeros. The mortar being given the same angle with the plane of the zeros, the plane of fire will practically intersect the object. To apply this method to a mortar mounted on a center-pintle carriage: On the rear of the platform, with the center of the pintle as a center, describe an arc. Find the point where the plane of the zeros cuts this arc, and mark the point *zero*. Divide the arc both ways from the point into degrees and parts of degrees. An indicator attached to the center of the rear transom (in the vertical plane containing the axis of the piece) will always mark the degrees to the right or left of the plane of the zeros.

A horizontal iron plate is permanently established on the parapet, the rear edge being on the crest and the center in the plane of the zeros. In order that the same instrument may be used at different places in a work, or be removed when not in use, a detachable plate containing the graduation and sights is adjusted to the permanent plate. By the use of this plate the index-arm will always be made to move in a horizontal plane. In the application of the method, place the plate containing the graduated arc on its bed, and level it by means of the tangent-screws; then place the arm to which the sights are attached on the plate. Traverse the chassis until the index on the rear transom indicates the required number of degrees as indicated by the instrument. If the arm of the instrument be to the right of the zero, traverse the chassis to the left; and *vice versa*. For the successful operation of this method with the center-pintle mortar-carriage, it is essential that the guides of the top-carriage should fit true and snug to the chassis-rails. See *Paddock Interpolator*.

DYER PROJECTILE.—A well-known form of projectile which is composed of a cast-iron body, *a*, shown in the cut, and a soft-metal expanding cup, *b*, attached to its base. The adhesion of the cup is effected by tinning the bottom of the projectile, and then casting the cup on to it. The cup is composed of an alloy of lead, tin, and copper in certain proportions. This projectile, as improved by Mr. Taylor at the Washington Arsenal, gives good results for even as large a caliber as 12 inches. A corrugated cap of tinned sheet-iron, *c*, is used with 3-inch projectiles to catch and direct that portion of the flame of the charge which escapes over the projectile on to the fuse to ignite it. See *Expanding Projectiles*.



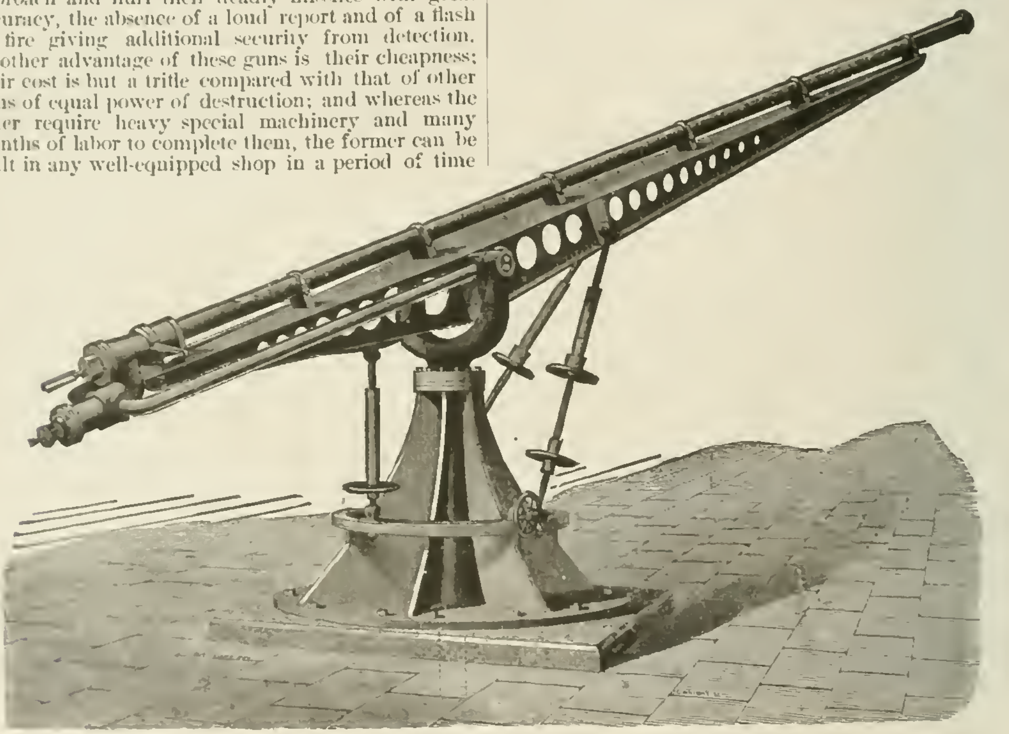
DYNAMICS.—That division of mechanics which contains the doctrine of the motion of bodies produced by forces. It is essentially a science of deduction from the laws of motion. The branches of dynamics capable of being treated in the present work will be found discussed under separate heads. We shall here confine ourselves to giving a view of the main branches and their correlation. I. The first branch of dynamics deals with the fundamental conceptions of the science, their names and definitions, such as velocity and the different kinds of motion, and accelerated motion; force, accelerating force, and moving force. Under this branch also falls the composition of motions. II. The second main branch of dynamics treats of the motion, free or constrained, of points. Here two problems are solved in each case—i.e., whether the motion be free or constrained—viz., a direct and an inverse problem; as, for example: 1. To determine the path of a point when the forces are given which act upon it; 2. To determine the forces or force acting on a point when its path is given. This division of dynamical problems into direct and inverse obtains in all the branches. It may be mentioned that it was by solving the inverse problem that Newton and Huygens effected their greatest glories in connection with dynamics. The method of treating the case of a free point now generally employed is due to Euler. See, under this head, CENTRAL FORCES, FALLING BODIES, and PROJECTILES. III. The third main branch of dynamics is concerned with the motion of a rigid system of points, or of a solid body. Few of the sub-branches of this part of dynamics are capable of exposition in this work, but see CENTER OF GYRATION, CENTER OF OSCILLATION, CENTER OF PERCUSSION, and PENDULUM. The honor belongs to D'Alembert of establishing a general method of treating problems in rigid dynamics. Previous to his time, each set of such problems was treated on some principle peculiarly applicable to itself. D'Alembert invented one (which goes by his name) applicable to all such problems. IV. The fourth main branch of dynamics is concerned with motions of rotation. A system of rigid points may be subject to two independent kinds of motion. It may suffer a motion of *translation* in space, or a motion of *rotation* about some point or axis within itself, or it may suffer at once a motion of translation and a rotatory motion. These may clearly be treated conjointly or independently; they are now uniformly treated independently, by investigating (1) the velocity and direction of the center of gravity of the system, and (2) the direction at each instant of the spontaneous axis of rotation passing through the center of gravity, and the velocity of the rotation of the system round that axis. To effect the second task, Poinsot proposed his theory of couples. For the conservation of living forces (*virium vivarum*), and the principle of least action, see FORCES. See also MOMENT. Dynamics is used by some recent writers with a wider signification, as denoting the science which investigates the action of force (1) in compelling rest or preventing change of motion, and (2) in producing or changing motion; the former branch being called *statics*, and the latter *kinetics*.

DYNAMIC UNITS.—Units for measuring forces and their effects. It is an axiom of mechanics that if a body at rest be impressed by a force and meet no resistance other than its own inertia, it will move in a straight line with a velocity which varies as the force; e.g., twice the force will develop twice the velocity. Also, if the mass of the body be increased, the force must be increased in like ratio to maintain the same velocity; e.g., double the mass will require double the force; or, if the force remain unchanged, double the mass will move with half the velocity. Combining the two statements, we find that the velocity varies directly as the force and inversely as the mass; velocity equals force divided by mass, or $v = \frac{F}{M}$. From this we have $F = Mv$. The unit of force is that force which will impart a unit of velocity to a unit of mass; that is, which will cause a unit of mass to move through a unit of space in a unit of time. If the force considered be that of gravitation, whose action in the same place is practically uniform, and if we remember that the measure of the force of gravitation in a body is the weight of the body, we have $W = Mv$. But if the mass be submitted to the force of gravitation, that is, if it be permitted to fall freely in a vacuum, it traverses a space of 32.16 feet in one second, at New York, approximately. We have then, by experiment, a value for v which makes our equation $W = M \times 32.16$, whence $M = W \div 32.16$. The English or American unit of force is one pound avoirdupois; and the corresponding unit of mass is 1 lb. divided by 32.16. The *unit of work* is the force which will raise a unit of weight through a unit of space. The two items are indicated in the name foot-pound, which by analogy might be exchanged in proper ratio for inch-ounce, ton-mile, etc. The corresponding French unit of work is the kilogram-meter. More generally the foot-pound is the work of a unit of force acting through a unit of space. The horse-power is an arbitrary unit, being the force required to perform 33,000 units of work in one minute. It may be called the *unit of the rate of working*. The French *cheval à vapeur* is 75 kilogram-meters per second, and is equal to 32,550 foot-pounds per minute, or a little less than our horse-power. The theoretical horse-power is merely a conventional quantity, the actual work of horses averaging about 17,000 and rarely exceeding 22,000 foot-pounds per minute.

DYNAMITE.—Nitro-glycerine is the most powerful explosive agent now known, but, uncombined with absorbents, is dangerous in manipulation, and unfit for long storage, from liability to spontaneous decomposition. This led to experiments being made with absorbents, and to the invention and introduction in 1866 of "dynamite" or "giant powder." Dynamite consists of 75 per cent of nitro-glycerine and 25 per cent of a light silicious earth. The best variety of the latter is known as "kieselguhr," an infusorial earth found in Hanover and in other countries; it is a fine white powder, capable of absorbing from two to three times its weight of nitro-glycerine without becoming pasty. The explosive properties of dynamite are those of the nitro-glycerine it contains. It is less liable to accidental detonation from shocks, and to spontaneous combustion, than nitro-glycerine; freezes at the same temperature, and if then in the state of loose powder does not lose the property of exploding from the action of the usual fuse, though it will act with less violence; frozen solid it cannot be fired. If saturated with water it retains very nearly its full explosive power, but requires a much more powerful primer to develop it; ignited in small quantities by a flame and unconfined, it burns quietly. It is not sensitive to friction or moderate percussion. Its explosive force is not quite so instantaneous as that of pure nitro-glycerine. The process of manufacture is simply to mix the nitro-glycerine with the dry, fine powder in a leaden vessel with wooden spatulas; when completed it has a brown color, resembling moist brown sugar. Dynamite is generally put up in paper cartridges, which are ignited by a fulminating-fuse. It is extensively employed in blasting, and has been adopted in the Torpedo Service of the United States army. By combining the ingredients of dynamite in judicious percentages a certain control can be exerted over the quickness of its action, and a classification similar to that of the different grades of gunpowder, but much more restricted in range, may be made. Various attempts to improve upon dynamite, by replacing its inert base with different materials, have produced such compounds as *glyoxiline, lithofracteur*, and *dualine;* none of these are improvements, as the bulk is increased in them in a higher ratio than the power. Glyoxiline is a mixture of gun-cotton pulp and potassium nitrate, saturated with nitro-glycerine; lithofracteur is composed of nitro-glycerine, silica, and mineral bodies; and dualine is a compound of nitro-glycerine with clean sawdust and potassium nitrate. The detonating force of the preparations containing nitro-glycerine in varying amounts is generally admitted to be due alone to the nitro-glycerine contained in them; yet it is far from true that their economic value as explosives can be thus compared. The element of time which determines whether a blow or a push is delivered is of primary importance, and upon it should be based the selection of the compound to be used. In flint-rock nothing exceeds the action of liquid nitro-glycerine; but for common earth gunpowder is far more effective. See *Dualine, Explosive Agents*, and *Nitro-glycerine*.

DYNAMITE-GUN.—Ever since the introduction of what are known as high explosives, some means have been sought by which they could be thrown from guns with accuracy, and a sufficient distance to render their use practicable for purposes of war. The nature of dynamite and nitro-glycerine precludes their being loaded in cannon and fired in the ordinary manner by gunpowder, which has been proved conclusively in many ways, and has almost invariably led to the destruction of the gun in which the attempt was made. Thus far the application of high explosives has been principally confined to torpedoes. These latter in their various forms have attracted a great deal of attention, the different Governments spending large sums in maintaining and perfecting them. The various systems, while undoubtedly advantageous in a great many cases, are nevertheless restricted in their very nature, and this has stimulated investigators to devise means by which high explosives, such as dynamite, could be projected "overland" with safety. It is now claimed that this knotty problem has been fairly solved, and, strange to say, by a medium long since applied to the propulsion of projectiles, but the use of which has never yet been attended with sufficient success to warrant its permanent introduction. We refer to the use of air and steam under high tension, and in the new dynamite-gun compressed air of very high tension is used as the propelling power. This new gun is the joint invention of a number of gentlemen under the leadership of Mr. H. D. Winsor, of New York, and one form of it is now undergoing a series of tests ordered by the United States Government, which are being made under the special direction of Lieutenant E. L. Zalinski. A description of the apparatus will be interesting as illustrating a new departure in appliances of war in a direction which has heretofore proved unsuccessful. The 4-inch gun now building at the Delamater Iron Works, and embodying the latest improvements, is represented on page 522. It will be seen to consist of a tube 40 feet in length and ¼ inch thick, mounted upon a light steel girder. The latter is trunnioned and is pivoted on a cast-iron base, thus enabling it to be swung into any desired position and range. To assist in the latter operation guys are placed on either side of the base, and their length can be altered and fixed by turning the hand-wheels shown. Compressed air is introduced to the gun from below and passes up through the center of the base, the pipe connecting with one of the trunnions (which are hollow); it is thence introduced into the pipe shown at the side of the gun leading into the valve. This valve is a continuation of the breech of the gun, to which it is connected by the short passage shown. An important feature of the system is the projectile, or dart, and upon which the success of the undertaking greatly depends. It consists essentially of two parts; and while several different modifications have been tried, the principal features are alike in all of them. The forward part of the dart consists of a thin brass tube into which the charge of dynamite is inserted. At the rear the tube is closed by a wooden plug, which flares out toward the rear until its diameter equals that of the bore of the gun. The forward end of the brass tube shows a mass of some soft material, into which is inserted a pin firmly held in place, the end being closed by a conical metal cap. Provision has also been made to allow a certain amount of air to act as a cushion for the dynamite cartridge, thus lessening the shock due to a sudden discharge. It is therefore claimed that, under ordinary circumstances, there is little danger of the charge exploding, since the pin cannot reach it and ignite the fulminate at its end; but when thrown from the gun, the impact against a body will displace the soft material and drive the pin home, causing an explosion. Another feature of the projectile is the power which it possesses to correct, to a certain extent, the deflection due to a side wind. It will be noted that with the present construction the center of gravity of the dart is some distance forward of its center of figure. A side wind would, therefore, acting upon the lighter rear part, have the tendency to deflect it so as to turn the head of the dart into the wind, which action would, in a measure, tend to keep it in the line of its trajectory. The firing of the gun, if the expression may be used, is accomplished in the following manner: The dart is inserted in the breech, and a gas-check placed in position; a lever then being moved, the valve is opened, and the air-pressure admitted. This method of discharge will, it is thought, obviate the danger of shock, which had heretofore proved a stumbling-block to success, and in addition the valve-controlling mechanism is automatically arranged to admit the air gently at first, to overcome the inertia of the projectile, following with full pressure, and finally closing at the proper time, as the dart leaves the gun.

In this gun we note a great step in advance, and are forced to believe that the day is not far distant when it will work great changes in warfare, both naval and military. As an auxiliary to coast and harbor defenses such a gun would be of great value; and placed on board small launches the latter might approach and hurl their deadly missiles with great accuracy, the absence of a loud report and of a flash of fire giving additional security from detection. Another advantage of these guns is their cheapness; their cost is but a trifle compared with that of other guns of equal power of destruction; and whereas the latter require heavy special machinery and many months of labor to complete them, the former can be built in any well-equipped shop in a period of time not exceeding a month, if need be. Nor does it seem unlikely that the system may be applicable to the use of armies in the field when engaged in siege-operations. Experiments made thus far have shown that the apparatus can be depended upon for a fair degree of accuracy and rapidity in firing. As regards the range attainable, the 2-inch gun now being tested has attained 1¼ miles with a pressure of 420 pounds to the square inch. In the 4- and 6-inch guns which are now in course of construction it is intended to use pressures of 2000 pounds and over, by the use of which a range of three miles is hoped to be attained. While this new application of compressed air to the propulsion of dynamite is no doubt valuable, it is hardly to be expected that it will, with its limited range, ever take the place of heavy ordnance—a point which its inventors wisely do not claim; but if it shall transpire that the gun is, in itself, a practical success for much shorter distances, it will be of the greatest importance and a valuable accession to our present appliances of war. Especially will this be so in the United States, where the coast-line is so extended, where good harbors are numerous, and appropriations for harbor defense so meager and so often *nil*, and where in fancied security the defenseless shores are exposed to hostile invasion; under these circumstances does it become necessary to substitute cunning for might, and rely upon some such means as torpedoes and dynamite-guns for protection from unexpected and uninvited approach.

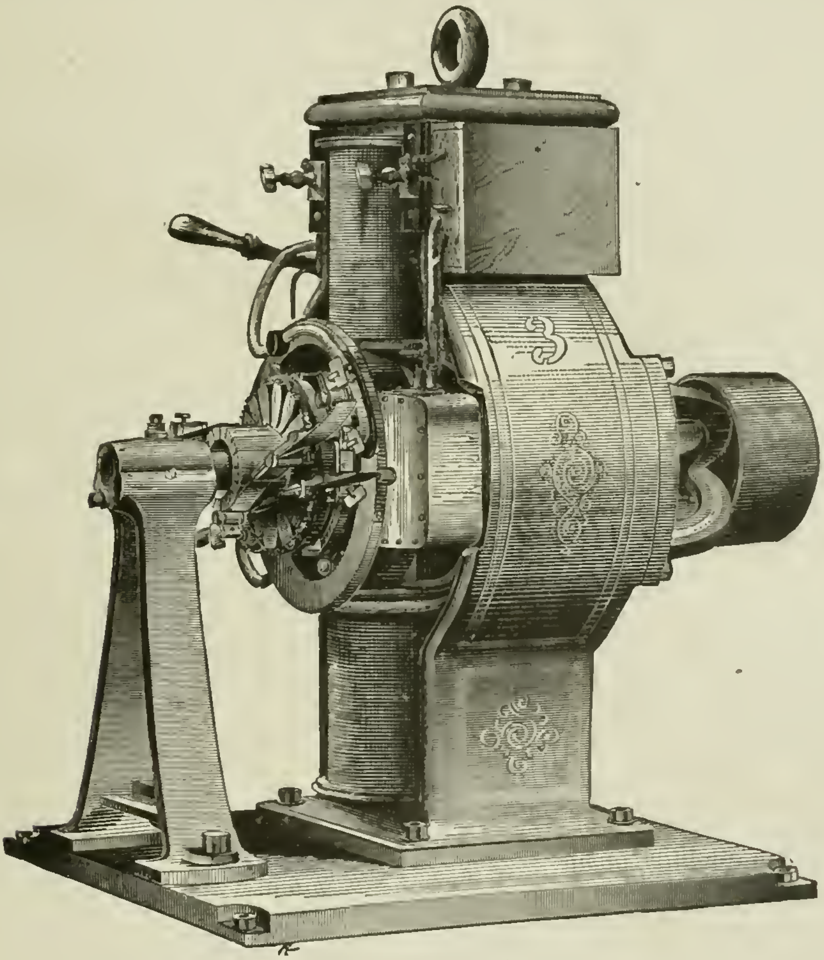


Dynamite-gun.

DYNAMO-ELECTRIC IGNITER.—This igniter, as at present employed, consists of a hard wooden plug, half an inch in length and about $\frac{3}{16}$ of an inch in diameter, having a score cut about its center, and a longitudinal groove on either side (the bottoms of which are $\frac{3}{16}$ of an inch apart) for the reception of the copper wires. There are also two cotton-covered (braided) copper wires, which are twisted together for about an inch, and are stripped of their insulation almost to the twist. These uncovered parts are pressed firmly into the grooves in the sides of the plug, and cut off so that they project about ¼ of an inch above the plug; the ends of the wires are now split with a very fine saw, and the distance between the ends carefully adjusted to $\frac{3}{16}$ of an inch, after which platinum wire No. 40 is stretched between them to form the bridge, and securely soldered to the ends of the split wires. A wisp of gun-cotton, is next wrapped around the platinum wire, and the ends of the copper wire pinched together sufficiently to take all strain off the platinum wire. The plug is now inserted in a hollow wooden case, two inches long, countersinking it about an eighth of an inch. The resistance of the wire is next found, and marked upon the case; it should fall between .40 and .45 ohm. The upper part of the case is filled with rifle-powder, the top being closed with a disk of cork, over which is poured some water-proof composition, and the whole is properly coated with shellac to render it water-proof.

The dynamo-electric fuse is made by inclosing one of the dynamo-electric igniters in a stout paper case about six inches in length, which is filled with rifle-powder to give more flame and consequently a more perfect ignition of the charge than can be obtained by the igniter alone. The ends of the case are properly closed, a wooden plug, with grooves cut in the sides for the wires, being used for the bottom, and a disk of cork for the top, which is coated with collodion, and seals the cork firmly into the case. The fuse is given two coats of brown shellac. The ends of the wires below the plug are stripped of their covering and brightened. See *Fuse*.

DYNAMO-ELECTRIC MACHINE. — All known methods of generating electricity can produce light of greater or less steadiness and brilliancy. Cavallo, in his treatise published a century ago, refers to a wires entering at binding-screws. The rods slide in the heads of glass pillars. The wires from the battery being connected, the points are made to touch, and are then withdrawn a line or two, when a dazzling light appears, approaching the light of the sun in purity and splendor. Its intensity prevents the naked eye from examining its form, but this may be ascertained by projecting the images of the points on a screen, when it is no longer painful to the eyes. The light is partly due to the incandescence of the tips of the carbon, and partly to an arch of incandescent particles extending from the one to the other. The positive pole is brightest and hottest, as may be proved by intercepting the current, when the positive



Dynamo-electric Machine.

light, different from the electric spark, produced by frictional electricity. A needle or wire presented to an insulated person, at the distance of about one inch from his body, while he is actually rubbing the tube, will, he says, exhibit a lucid pencil of rays, seemingly issuing from the point and diverging towards the person; and other like experiments are described by Watson and other early writers. Light from battery electricity was first discovered by Sir Humphry Davy at the Royal Institution, London, in 1810, when, on the continuity of a current from 2000 cells being broken, a brilliant light was seen. To this the name of the "voltaic arc" was given, and the points where the current was broken were termed "electrodes." An early and simple arrangement for producing this light consisted of two carbon points fixed into hollow brass rods, which are connected with the battery by

pole continues red for some time after the negative pole has become dark. During the maintenance of the light a visible change takes place in the condition of the poles, and the positive pole becomes blunt by the loss of particles of carbon. The wasting away of the poles renders the distance between them too wide to allow of the passage of the current, and the light is thus suddenly extinguished, until again renewed by contact and removal. The heat of the *voltaic arc* is very intense. Quartz, the sapphire, magnesia, lime, and other substances equally refractory are forced by it into a state of fusion. The diamond when placed in it becomes white hot, swells up, fuses, and is reduced to a black mass resembling coke. The electric light can be produced in a vacuum, and below the surface of water, oils, and other non-conducting liquids, and is thus quite independent of the action of the air. In 1820 Oersted proved the identity of electricity and magnetism; but it remained for Faraday, in 1831, by his great discovery of induced currents, to render practicable the application of electricity to the production of a good artificial light. It was not, however, until 1853 that the magneto-electric machine was actually applied to the purpose; and in 1857 the first great practical trial took place, when Faraday had the satisfaction of seeing his conception carried into effect. This trial of Holmes's machine resulted in the electric light being then introduced into the South Foreland light-house, December 8, 1858, and later the light was adopted at Dungeness. The French Government adopted the light for two light-houses near Havre in 1863.

The problems to be solved in the production of electric light are to supply a constant and equal current (which the battery-electricity does not yield), and to provide a form of electrode which will not cause the light to blink or go out by wasting away. The first generating-machines were "magneto-electric," revolving coils in front of permanent steel magnets (or contrariwise, revolving magnets in front of the coils), but some later machines are "dynamo-electric," based on a discovery simultaneously made by Werner Siemens, Varley, and Wheatstone, that by revolving coils in front of soft iron electro-magnets the residual magnetism in the iron would gradually be augmented, dynamic force being thus converted into electricity. The currents created by machines of either sort are alternate; but where, as in the case of some forms of lamp, the current must proceed in one direction, the alternate currents are made continuous by the use of a commutator. There are a large number of machines in use for generating currents for producing the electric light. The dynamo-electric machines of the Excelsior Electric Company of New York, represented on page 523, are believed to be superior to all others for the illumination of large areas by the electric arc-light. As the dynamo requires less power than others, the machines can be run where it would be found impracticable to use others, and a special point in their favor is that they require no more attention than any ordinary piece of machinery. Owing to the peculiar construction of these machines, a very powerful magnetic field is obtained with a comparatively small number of convolutions of copper wire around the inducing magnet. The inductor is sectional, making it possible to equip it with wire helices after they have been completely finished on a mandrel and their insulation thoroughly tested. The commutator-bars are fastened to a stone plate and are separated from each other by air spaces. If kept clean, an accidental short-circuiting is impossible. The current from the machine is sent through the lamps or withdrawn from them by means of a switch, which does not break the circuit suddenly and thereby give rise to a dangerous extra current; but it merely deprives the magnetic helices of the exciting current, lowering the power of the magnetic field down to zero and short-circuiting the inductor-helices.

The regulation of the lamp is effected in the following manner: The movement of the upper carbon-holder is controlled by a train of wheels, carried on a lever which swings on a fulcrum. The escapement is arrested when the lever is swung so as to lift the carbons apart, and set free when they are caused to approach each other. The end of the lever carries a U-shaped iron core, whose straight parts are surrounded by fine wire helices fastened to the floor of the lamp-case, and has attached to it a retractile spring capable of adjustment. The iron core of a coarse wire helix is resting on the same lever, and depresses it, owing to its weight overcoming the pull of the spring. This helix forms part of the light-circuit, and raises its core as soon as the current is sent through the lamp, thereby allowing the spring to lift the carbons apart by means of the lever and gear-train. The fine wire helix is connected with the positive and negative terminals, and forms a shunt to the light-circuit. When the carbons burn with a small separation the resistance in the light-circuit is low, and but a small portion of the current traverses the shunt-helix; but as the carbon ends are consumed by the current, the separation increases, and the current has more resistance to overcome in the arc. The shunt will receive a constantly increasing amount of current, and will draw its core and the lever attached to it down till the escapement is released from its detent, and the wheel-train allowed to move sufficiently to let the carbons approach. As soon as the proper length of arc has been re-established, the shunt-helix—the current passing through it being diminished—allows its core to be lifted a little by the retractile spring, and the escapement engages again its detent. The core of the main helix remains firmly drawn up by the strong suction of the helix in the light-circuit, aided by the attraction of an iron armature upon the helix, until the current is cut off and the light thereby extinguished. If a number of lamps are burning in series, the failure of one to feed its carbon down would soon lead to the extinction of all. To prevent such an occurrence, each lamp is provided with an automatic cut-out, which furnishes another path for the current when the distance between the carbons becomes abnormally great. This device consists of a light iron plate hung in pivots near the shunt-helices, and which is forced towards them by the combined attraction of the helix itself and its core when an undue amount of current flows through the shunt. In swinging over it makes contact between the two ends of the helix in the light-circuit, depriving it of the current, and thereby causing its core to drop. But it has also put a lever attached to it in such a position that the falling core can force it against a contact, completing a short circuit between the terminals of the lamp. The hand-switch allows the attendant to re-carbon any lamp of a series while the others are burning. See *Electric Light.*

DYNAMOMETER.—A device for measuring the force which does work in overcoming resistance and producing motion. The foot-pound, as a unit of work, has for its factors the force acting and the distance through which it acts. The larger unit, the horse-power, besides these factors has a third, the time during which the force is exerted. Hence, in getting the data from which the work of a machine is to be calculated, we are to observe the force, the distance, and the time required to accomplish a certain result. Strictly speaking, the dynamometer indicates the first of these items, but it may be so arranged as to show both the others. Dynamometers are designed to indicate the force of *traction*, of *thrust*, or of *rotation*. A traction-dynamometer may be interposed, for example, between a team of horses and a reaper or a plow, to measure the force exerted by the horses in drawing the machine. It is usually some sort of spring balance, fitted with an index and a scale; the figures on the scale show the number of pounds required to bring the index to the corresponding points, if the instrument were hung up and weights suspended by it. A dynamometer for thrust is often connected with the screw-shaft of a steamship, to measure the force with which the screw is driving the vessel through the water. Rotary dynamometers measure the force of a mill-shaft, either by showing what force is required to hold the shaft in check, by absorbing the motion, or what force the shaft transmits to other machinery. Nearly all forms of dynamometers are too complex to be described without the help of elaborate drawings and technical descriptions, for which the reader is referred to special works on mechanism. The use of the dynamometer in skillful hands has acquired great value in exchanging the rough and usually overestimated guesses of the efficiency of machines for the exact determination of their performance.

DYNASTY.—A line, race, series, or succession of princes of the same blood who have reigned in any particular country; as, the Dynasty of the Plantagenets, or Bourbons.

DYSODILE.—A yellow or grayish laminated bituminous mineral, often found with lignite. It burns vividly, and diffuses an odor of asafœtida.

E

EAGLE.—1. The eagle, as a military standard, was adopted by the Romans, and even by nations preceding them in history. The Persians in the time of Cyrus the Younger bore an eagle on a spear as a standard. The Romans for some time used the eagle, the wolf, the boar, the horse, and the minotaur for standards, but afterwards abandoned the last four and confined themselves to the first. The Roman eagle, sometimes of gold, but more frequently of silver, was about as large as a pigeon with extended wings, and was borne on the top of a spear, with a cross-bar or a shield to support it. Some of the eagles were represented as holding thunderbolts in their talons, and usually bore the name of the legion to which each respectively belonged. The eagle was sometimes made of steel, but rarely. In modern times France, Russia, Prussia, Austria, and the United States of America have all adopted the eagle as a national military symbol. The Austrian eagle is represented double-headed.—2. The eagle is used heraldically as an emblem of magnanimity and fortitude. It is variously represented, the best-known mode being displayed or spread out, either with two heads—as in the arms of the Austrian Empire, in which case it is popularly known as a spread eagle—or with one head, as in the arms of the German Empire.—3. The Order of the Black Eagle was founded by the Elector of Brandenburg on 17th January, 1701, the day of his coronation as King of Prussia. The number of knights, in addition to the princes of the royal family, was originally 30, but it is now unlimited. They must at their nomination be at least 30 years of age. They must prove their noble descent for four generations through both parents. A chapter is held twice a year. The insignia of the Order consist of an octagonal cross of blue enamel, and a black eagle displayed between each of the arms of the cross. The cross is suspended by a broad ribbon of orange-color across the left shoulder, and it is accompanied by an embroidered silver star, fastened on the left breast. The center of the star represents a black flying eagle, holding in one claw a laurel wreath, and in the other a thunderbolt, with the legend *Suum cuique*. Fifty ducats must be paid by every new member for the support of the orphan asylum at Königsberg, and he then receives gratis the costume and insignia of the Order. As the Black Eagle is the highest Order in Prussia, no member of it, with the exception of foreign princes and Knights of St. John, is permitted to wear any other order along with it; and as it is generally granted only to those who are expected to be about the person of the king, no one who holds it is permitted to travel from the Court more than 20 German miles without giving notice. Knights of the Black Eagle are likewise Knights of the Red Eagle, first class.—4. The Order of the Red Eagle was founded in 1734 by the Markgraf George Frederick Charles, as a reorganization of the "Ordre de la Sincérité," which had been instituted in the beginning of the century by the hereditary Prince of Anspach and Baireuth. After passing through various modifications, the Order of the Red Eagle was raised in 1791 by Frederick William II. to the rank of the second order in the Monarchy, and it was then that the decoration of a white enameled Maltese cross, surmounted by a royal crown, with the Brandenburg eagle in the corner, was adopted. All the Knights of the Black Eagle were received into this new Order; and it was latterly decreed that only those who had been decorated with the Red Eagle, in the first instance could be received into the Black. In 1810 the Order of the Red Eagle was reorganized, and two more classes were added to it. In 1830 the second class was subdivided into two, one of which only was allowed to wear a square star.

Star of the Order of the Black Eagle.

EAR.—The name given to the lug or loop formerly cast on mortar-shells. The term was also usually applied to the "dolphin" on light guns. The object originally of casting mortar-shells with *ears* was to assist in placing the shell in the mortar, but lewis-holes are now adopted for that purpose.

EAR-BED.—In gun-carriages, the front and hind *ear-beds* connect the corresponding ends of the frame sides, between which latter and parallel to them lie the summers.

EARL.—The early relation which subsisted between the Duke and the Count has been explained under the former title. In Europe, generally, it was not till the Count came to be recognized as a subordinate officer to the Duke, governing a district of the province committed to the latter, that the Earl assumed the position of the Governor of a County, by the name of which he was commonly known. The title of Duke, if it had ever existed, early disappeared in England, and was not revived till the time of Edward III. After the Norman Conquest the French term Count was substituted for Earl; but it held its place only for a very short time as the title of the officer, though it has continued ever since to give a name to the district over which he presided, and a title to his wife. William the Conqueror, after the Battle of Hastings, recompensed his chief Captains by granting to them the lands and offices of the Saxon nobles; but by making the title of Earl hereditary he took, unintentionally perhaps, the first step towards changing it from a title of office to a title of dignity, and thus depriving it of substantial power. The form of creation of an Earl formerly was by the king girding on his sword, and placing his coronet on his head and his mantle on his shoulders; but Earls are now created by letters-patent; and it is not unusual for them to depart so far from the old notion of their being Territorial Officers, as to take as their titles their own names, with the prefix Earl—e.g., Earl Grey, Earl Russell, Earl Spencer, etc. At present the number of Earls, including the peerages of Scotland and Ireland, exceeds 200.

The Earl's coronet is a circle of gold, rising at intervals into eight pyramidal points, or spikes, on the tops of which are placed as many pearls, alternated with strawberry-leaves. See *Crown* and *Duke*.

EARL MARSHAL.—An office of great antiquity, and formerly of importance. There seems reason to believe that the Marshal of England, afterwards the Earl Marshal, was a distinct officer from the Marshal of the King's House, but the point is not altogether clear, and there is, consequently, some difficulty in determining which of the offices was held by the Mareschals, Earls of Pembroke. For many generations the office has been hereditary in the family of the Dukes of Norfolk, though the Earls Marshal having, to an unusual extent, had the fate to die either childless or without heirs-male, the line of descent has been by no means a direct one. The last grant is by King Charles II., and bears date 19th October, 1672. The Earl Marshal presided jointly with the Constable over the Court of Chivalry, the last proceedings of which are said to have taken place in 1631. He is the head of the College of Arms, which has jurisdiction in descents and pedigrees; determines all rival claims to arms; and he grants armorial bearings, through the medium of the Kings-of-Arms, to parties not possessed of hereditary arms. The office of the Lyon in Scotland is generally supposed to correspond to that of the Earl Marshal in England, but not quite correctly. The Lyon having been subordinate to the Marshal and Constable of Scotland, his office was more nearly that of the Kings-of-Arms in England; with this difference, that it extended to the whole kingdom.

EARNEST GUN.—A breech-loading rifle having a fixed chamber closed by a movable breech-block, which rotates about an axis parallel to the axis of the barrel, and on the left side. The block is in two sections, the foremost of which revolves with a screw motion on that in rear, which alone is fastened to the hinge. They are both perforated for the firing-pin and striker. The forward section is provided with a handle by which the breech is opened and closed, receding from and approaching the barrel alternately. The lock is peculiar, involving a device for causing the striker to rebound after delivering its blow upon the firing-pin. The arm is especially designed to prevent the escape of gas from defective cartridges.

EARTH-HOUSE.—*Earth-houses, eird-houses*, or *yird-houses*, were the names which seem to have been given throughout Scotland to the underground buildings which in some places are called also "Picts' houses," and in others, it would appear, "weems," or caves. Martin, in his *Description of the Western Islands*, printed in 1703, when their use would appear to have been still remembered, speaks of them as "little stone houses built under ground, called earth-houses, which served to hide a few people and their goods in time of war." The earth-house, in its simplest form, is a single, irregularly-shaped chamber, from 4 to 10 feet in width, from 20 to 60 feet in length, and from 4 to 7 feet in height, built of unhewn and uncemented stones, roofed by unhewn flags, and entered from near the top by a rude doorway, so low and narrow that only one man can slide down through it at a time. When the chamber is unusually wide, the side-walls converge, one stone overlapping another, until the space at the top can be spanned by stones of 4 or 5 feet in length. In its more advanced form, the earth-house shows two or more chambers, communicating with one another by a narrow passage. There are instances in which one of the chambers has the circular shape and dome-roof to which archæologists have given the name of the "beehive-house." Quite frequently as many as forty or fifty earth-houses are found in the same spot, as in the Moor of Clova, not far from Kildrummy, in Aberdeenshire. They appear to have been almost invariably built in dry places, such as gravelly knolls, steep banks of rivers, and hillsides. They are generally so near the surface of the ground that the plow strikes upon the flagstones of the roof, and thus leads to their discovery. The object most frequently found in them is a stone quern, or hand mill, not differing from that which continued to be used in remote corners of Scotland within the memory of living men. Along with the quern are generally found ashes, bones, and deer's horns; and more rarely small round plates of stone or slate, earthen vessels, cups, and implements of bone, stone celts, bronze swords, gold rings, and the like. Occasionally the surface of the ground beside the earth house shows vestiges of what are supposed to have been rude dwelling-houses, and folds or inclosures for cattle. This, with other things, would indicate that the earth-houses of Scotland and Ireland (for they are found also in that Island) were put to the same purpose as the caves which, as Tacitus tells us, the Germans of his day dug in the earth, as storehouses for their corn, and as places of retreat for themselves during winter or in time of war.

EARTHWORKS.—In fortification, a general name for all military constructions, whether for attack or defense, in which the material employed is chiefly earth. The word *earthwork*, however, has lately received a new importance, in reference to a discussion among Military Engineers whether earthwork defenses generally are better or worse than those of masonry. The subject cannot be discussed here, but its general character may be indicated. The fracture of the Russian granite fortifications at Bomarsund, and the obstinate defense made within the earthen defenses at Sebastopol, led many writers, about the year 1855, to express a preference for earthworks instead of stoneworks. Mr. J. Fergusson has especially distinguished himself by his advocacy of this view. The reasons urged are, that masses of earth can be more quickly and cheaply put up than masses of masonry; that in most places earth is more readily obtained than stone; that if an earthwork be knocked to ruin by balls and shells, it can be repaired in a very short time; and that the defenders are not exposed to so much injury as in masonry-works, where splinters of stone fly about in a perilous way. The late Sir John Burgoyne, the leading Military Engineer in England of his day, combated these views. He contended, among other things, that as a given amount of cannonading will make a much larger breach in earthwork than in stonework, the latter is best fitted to prevent capture by assault. He insisted that earthworks should be regarded rather as temporary expedients than as purposed and permanent constructions; and he claimed the authority of Continental Engineers in support of this opinion. See *Field-fortification*.

EAST INDIA ARMY.—When the East India Company first sent factors or agents to India, an army was not thought of. Military forces arose out of the exigencies of the times. Some of the first troops in the Company's pay were mere adventurers; some were liberated convicts; some deserters from European armies. Gradually organization was introduced, and improved arms furnished. As the power of the Company increased, natives entered the battalions; until at length most of the troops were Hindoos or Mohammedans drilled by non-commissioned officers sent out from England. A few regiments were raised in England; a much larger number were raised in India; but all alike were officered by the Company's favored English officers, largely paid, and having many opportunities for making rapid fortunes. The ranks were filled by enlistment; the Company never compelled the natives to become soldiers; the pay offered was always such as to induce a sufficient number of men to enter. Their periods of leave of absence were liberal; and after a certain number of years' service they retired on a pension sufficient to support them for the remainder of their days.

At the period immediately preceding the outbreak of the revolt in 1857, the army in the pay of the Company comprised about 24,000 Royal troops (lent to, and paid for by, the Company); 18,000 European troops, raised and drilled by the Company in England; 180,000 native regulars; and 60,000 native irregular horse—making about 280,000 in all. This large force was irrespective of 40,000 contingents furnished by dependent native princes, and of the native armies belonging to the independent and semi-independent princes. The Company's troops formed three distinct armies, each under its own Commander-in-Chief, and each stationed in one particular Presidency. In these three armies three kinds of troops—Europeans, native regulars, and native irregulars—had their own special organization. In order to secure unity of action when necessary, it was customary to give the Commander-in-Chief of the Bengal army precedence over those of Madras and Bombay; he was, in effect, Commander-in-Chief of the whole of the Company's forces. There were too few English officers with the native regiments, and these, in most cases, knew too little of the men under their command. This was not the *cause* of the revolt in 1857, but it was one of the circumstances that led to the rapid spread of the revolt when once begun. Speaking generally, it may be said that the armies of the Madras and Bombay Presidencies remained faithful, especially the infantry. It was in the Bengal army that the disruption chiefly occurred. The irregulars, both cavalry and infantry, raised amongst the Sikhs and Punjabees, were in almost every case faithful.

In August, 1858, the Act which transferred the Government of India from the Company to the Crown received the Royal assent. The army was transferred as well as the political power. As the Sikhs had behaved well, most of the regiments from the Punjab were retained, as well as most of the native regiments in the Bombay and Madras Presidencies; but it was not deemed expedient to restore the native regiments of Bengal proper, which had proved so treacherous. In that year, at the suggestion of Earl Canning, a Commission was appointed to inquire into the whole circumstances relating to the reorganization of the army. The Company originated the inquiry, but the Commissioners did not make their report till after the transfer of the Company's powers to the Crown. Although the Commissioners' report was presented in the summer of 1859, very little was effected during the remainder of that year, or in 1860, to reorganize the Indian army; matters were kept together in a provisional way. Meanwhile, when the European troops of the Company's army were turned over to the Crown, a disturbance, amounting almost to a mutiny, occurred. The men claimed that, as they had enlisted in the Company's service, they ought not to be transferred without their own consent being asked, or without receiving a bonus on re-enlisting. To prevent a dangerous excitement, the Government allowed such as chose to retire. In 1861 an Act was passed reorganizing the Indian army. The *British* portion of it now forms part of the Queen's army generally, with certain honorary distinctions, and takes its turn at home and in the Colonies like the rest; but the expenses are paid out of Indian, not Imperial, revenues. The *native* portion is managed wholly in India; but during the Eastern crisis, connected with the war between Russia and Turkey, a considerable force of native Indian troops were sent to Malta, for service in Europe—in case of England being involved in war. On the reorganization of the Indian army in 1861 the 21st Hussars, with the 105th, 106th, 107th, 108th, and 109th Foot, were formed from the European troops previously in the service of the East India Company. See *Army* and *British Army*.

EASTMAN BREECH-APPARATUS.—An efficient apparatus for opening and closing the breech of certain guns when firing rapidly. The breech-screw is divided into six parts, in the direction of its axis, the threads being removed from every other one, both from the plug and from the breech of the gun. When the breech is to be closed, the threaded portions of the plug are presented so that they come opposite the smooth parts of the breech-hole. The plug is then pushed in, when a sixth of a turn with a handle brings the screw of both parts together. A strong cranked lever serves to manipulate the breech-plug, by turning which the threads of the screw enter the corresponding grooves. The movement in the contrary direction disengages them. The breech being closed, the lever-handle is prevented from moving back, and thus allows the plug to be unscrewed by a short metal catch, working freely on a stud placed in the upper part of the right sight of the breech. This catch lifts as the lever-handle reaches it, and allows it to pass, but drops by the action of a spring when the handle has passed, and thus prevents the lever from moving to the left; a stud on the breech prevents it from moving to the right. The weight of the breech-plug for a 9½-inch gun is about 500 pounds; therefore a support, or collar, is used to hold it when withdrawn. This is a metallic frame carrying a bracket, hinged to the side of the breech near the opening. It has a kind of gutter in which slides the screw portion of the plug. This support being placed in a line with the bore, the hand-gripe at the middle of the breech-plug is seized, and the screw being disengaged, a strong pull will bring the whole to the rear. The impulse given swings it open, the breech-screw remaining fixed in its support, or collar. A safety-catch held by a spring secures the collar fair in a line with the bore. To obviate the danger resulting from a neglect to screw up the plug when the breech is closed, the lock-lanyard, which has a bob on it, is made to pass through the eye of a piece of iron fixed to the breech. When the handle is not in its place, that is, when the plug is not properly screwed in, a spring closes the eye and does not allow the bob to pass. When the handle is in position with the plug screwed up, it opens the eye and allows the bob to pass, when the gun can be fired.

EBONY.—This wood, remarkable for its hardness, heaviness, and deep black color, is the heart-wood of different species of *Diospyros*, of the natural order *Ebenaceæ*, the same genus which produces the date-plum, kaki, and other fruits. The best ebony, excelling in uniformity and intensity of color, is the produce of *Diospyros ebenum*, which grows in great abundance in some of the flat parts of Ceylon, and is a tree of such magnitude that logs of its heart-wood 2 feet in diameter, and varying from 10 to 15 feet in length, are easily procured. Ebony is used in the arsenals for handles, press-screws, etc.

EBOULEMENT.—A term applied to the crumbling or falling of the walls of a fortification.

ECCENTRIC.—1. A device applied to the truck-wheels of top-carriages and beds of mortars in sea-coast artillery to give either rolling or sliding friction at will. A similar device is attached to the chassis near the pintle to enable it to be readily traversed when *in gear*, and give it stability when *out of gear*. —2. In machinery, a contrivance for taking an alternating rectilinear motion from a revolving shaft. It consists of a circular disk or pulley, fixed on a shaft or axis which does *not* pass through the center of the disk. The disk has a groove upon its circumference in which the hoop—by means of which the rod is attached to the disk—slides. As the eccentric revolves with the axis, the hoop is alternately raised and lowered, and with it the rod which is keyed into it. The extent of the rise and fall of the rod is equal to twice the distance between the centers. The eccentric is chiefly used where a subsidiary motion of small power is required, as for working the force-pump that supplies the boiler of a steam-engine.

ECCENTRIC CHUCK.—A chuck attached to the mandrel of a lathe, and having a sliding piece which carries the *center*. This piece is adjustable in a plane at right angles to the axis of motion by means of a set-screw, and carries the center to one side of the axis of motion. By its means circular lines of varying size and eccentricity may be produced. No oval or ellipse is produced thereby, but circles on the face of the work, with their centers at such distance from the axis of the mandrel as may be desired.

ECCENTRIC CUTTER.—A cutting tool placed upon the slide-rest, and having a rotation by means of a wheel and shaft, the cutter being attached to the end of the latter. The rotation is obtained by an *overhead motion*, and the eccentricity by fixing the cutter at different distances from the center by means of the groove and screw. The action of the eccentric cutter differs from that of the eccentric chuck in this: in the latter the work is rotated and the tool is stationary; in the former the work is stationary and the tool revolves. When the motions are used in conjunction, the patterns are capable of unlimited variation.

ECCENTRIC PROJECTILE.—A spherical projectile, in which the center of inertia does not coincide with the center of figure. Such projectiles are subject to great deviations, which can be predicted as to direction by knowing the position of the center of inertia of the shot in the bore of the gun. See *Projectiles.*

ECCENTROMETER.—An instrument for determining the position of the center of gravity of a projectile. See *Center of Gravity.*

ECHARGE.—A term employed to signify that a column of troops is struck at a very oblique angle. Also written *Feu d'écharge.*

ECHAUGETTE.—In military history, a word signifying a watch-tower, or kind of sentry-box.

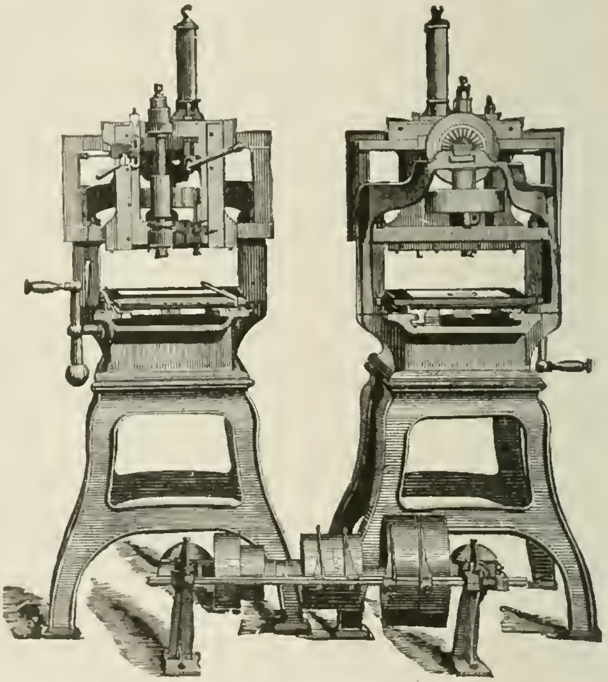
ECHELON.—A military term applied to such a formation or arrangement of troops that, if viewed from a height, they would present some analogy to the successive steps of a ladder or staircase. The several divisions of the force, although parallel, are no two on the same alignment. Each has its front clear of that in advance, so that, by marching directly forward, it can form line with it. There are two kinds of echelon, *direct* and *oblique. Direct echelon* is adapted for attack and retreat; while *oblique echelon* (oblique in reference to the original front of the line) is adapted for changing position, or for getting on the enemy's flank.

ECLAIREURS.—Literally, the feelers of an army. They are bodies, generally of light cavalry, sent to the front or the flank of an army to obtain intelligence as to the movements of the enemy. They are not used as exceptional or distinct bodies, but all the light cavalry is called upon to perform that duty. When the first Napoleon was Chief Consul of France, he raised a regiment of Eclaireurs for the protection of Paris. In the Continental War of 1870, Eclaireurs were employed both by the Germans and French.

ECLOPES.—A military term to express those soldiers who, though invalids, are well enough to follow the army. Among these may be classed dragoons or horsemen whose horses become lame and cannot keep up with the troop or squadron. They always march in rear of the column.

ECOLE POLYTECHNIQUE.—One of the most celebrated Military Academies in France. In 1793 all the public establishments in Paris were in a convulsed state, owing to the Revolution. In 1794 M. Lamblardie, Director of the *Ponts et Chaussées*, proposed the establishment of an *Ecole Centrale des Travaux Publics*, to thoroughly educate young men for military, naval, and civil engineering. Monge and Carnot favoring his plan, it was carried out, and a School established at the Palais Bourbon. The first list of Professors comprised names which afterwards acquired European celebrity—including those of Legrange, Prony, Monge, Hachette, Hassenfratz, Fourcroy, Vauquelin, Berthollet, Chaptal, Pelletier, Guyton-Morveau, and Merimée. In 1795 the name was changed to Ecole Polytechnique; many alterations were made in the organization; artillery studies were included in the course; and the pupils were ordered to wear a uniform. When Napoleon went to Egypt, 40 pupils from the Ecole Polytechnique accompanied him, many of whom greatly distinguished themselves. Napoleon made the organization of the School more strictly military in 1804, to identify it more fully with the army. The School was dissolved in 1816, again in 1830, and again in 1832, on account of the impetuous way in which the pupils mixed themselves up with the political disturbances of those years; but as the School suited the military genius of the French Nation, it was re-established on each occasion, after the restoration of tranquillity. Candidates can be admitted only by competitive examinations, which take place yearly. A Proclamation from the War Office, made public before the 1st of April, informs intending competitors of the subjects on which they are to be examined, and the time when the examinations begin. To be eligible as a candidate, the youth must be French, and must be more than sixteen and less than twenty years of age before the 1st of January following; but soldiers are admissible up to the age of twenty-five, provided they can give proof of two years of service in the regular army. The cost of board alone is 1000 francs ($200) a year. A complete course of instruction lasts for two years; when the pupils who have satisfactorily passed the final examinations have the privilege of choosing, from among the various public services supplied from the School, the particular branch they wish to enter, as the Artillery, the Engineers, the Staff, the Department of Telegraphs, or some of the other government monopolies. The School was reorganized by a decree of the 15th April, 1873. See *United States Military Academy.*

ECONOMY.—In a military sense, this term implies the minutiæ or the interior regulations of a regiment, troop, or company. Hence "regimental economy."



Edging-machine.

ECORCHEURS.—A name given to bands of armed adventurers who desolated France and Belgium during the fifteenth century, beginning about 1435, and who at one time numbered 100,000. They are said to have stripped their victims to their shirts, and to have flayed the cattle. They were favored by the English Invasion and the Civil Wars.

ECOUTES.—Listening-galleries. Such are known to engineers and others in connection with siege-works. These galleries are run out under and beyond the glacis at regular distances in the direction of the besiegers' works, and enable the besieged to hear and estimate how near the besiegers have carried their mining operations.

ECRETER.—To batter or fire at the top of a wall, redoubt, epaulement, etc., so as to dislodge or drive away the men that may be stationed behind it, in order to render the approach more easy. *Ecreter les pointes des palissades* is to blunt the sharp ends of the palisades. This ought always to be done before attacking the covered-way, which is generally fenced by them.

ECREVISSES.—Armor entirely composed of imbricated plates, and commonly called a *suit of splints* in England.

ECU.—A large shield which was used by the ancients, and carried on the left arm to ward off the blows of sword or saber. This instrument of defense was originally invented by the Samnites. The Moors had *ecus*, or shields, sufficiently large to cover the whole of their bodies. The *clipei* of the Romans differed from the *ecu* in shape only; the former being entirely round, and the latter oval.

EDGE.—The thin or cutting part of a sword, saber, or other cutting weapon or implement.

EDGING-MACHINE.—A machine much used in the manufacture of small-arms, for milling inside and out of metal forgings and castings of irregular shapes to an exact shape and size of pattern required. The machine is shown in detail on the opposite page. Power is supplied by a cone-pulley having two speeds (and two friction-pulleys on countershaft, which allow four changes of speed) driving bevel gears which have a direct belt-connection with the cutter-spindle. This arrangement makes the working of the slide very easy. The pattern, or former, is secured to the sliding table, which has a forward-and-back motion, operated and controlled by the hand-crank at the side of the machine. An automatic feed can be substituted when desired. The top or cross slide which holds the cutter-spindle, and moves at right angles with the bed, is operated by the hand-lever in front and has a counterbalance-spring and a notch adjustment. This cross-slide also has a pin which is brought to bear against the pattern, and the four motions to the two slides will allow the pin to follow any pattern secured to the lower table or sliding bed. The work to be cut into shape is also secured by suitable fastenings to the lower table, and as the pin passes around the pattern, so the cutter-spindle will pass around the piece of work and describe the same outline and dimensions as the pattern used. By using a cutter with teeth on the lower end, good surface-milling is nicely and quickly done. The machine as commonly employed in Government arsenals and represented in the drawing has the following general dimensions:

Friction-clutch pulleys on countershaft, 8 and 12 inches by 3 inches face.

Countershaft runs for slow speed	150 revolutions.
" " " fast "	220 "
Working surface of table	14 by 10 inches.
Movement of table	16 "
" " cross slide	9 "
Distance from bed to cross-slide	4⅜ "
Up-and-down movement of spindle	3½ "
Weight of machine	1100 pounds.

These dimensions are frequently varied for special classes of work. See *Profile-machine.*

EDUCATION.—A civil branch of the English army, presided over by a Director General of Military Education, under whose orders are the Military Inspectors of Schools. All officers who are candidates for the Staff College are examined under the orders of the Director General. The studies carried on at the College are regulated by him in concert with the Commandant of that Institution. The final examination of officers who have passed the prescribed time at the College takes place under his cognizance, and a report is submitted by him to the Horse-guards of the qualifications of the officers examined. His Department supervises all Regimental Schools, Garrison Libraries, etc. In fact, on all subjects of education in the army he is the Director and Referee. The following is a list of the Government Educational and Scientific Establishments in England: the Department of Artillery Studies; the School of Engineering at Chatham; the School of Gunnery at Shoeburyness; the School of Instruction at Aldershott; the School of Musketry at Hythe; the Army Medical School, Netley; the Military School for Music at Hounslow; the Royal Military Asylum at Chelsea; the Royal Hibernian Military School, Dublin. See *Artillery School.*

EFFARE.—In Heraldry, a term which signifies that the animal to which it refers is to be represented as rearing on its hind-legs, as if it were frightened or enraged. Also written *Effrayé.* See *Heraldry.*

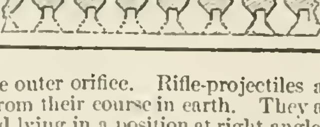
EFFECTIVE.—A term used, in a military sense, to denote the number of men actually borne and doing duty on the strength of a company or regiment, in the field or on parade.

EFFECTS.—The property of a deceased officer or soldier. On the death of either, a Committee of Adjustment is formed to take charge of the property, and to adjust the affairs of the deceased, as directed by law. See *Deceased Officers and Soldiers.*

EFFECTS OF PROJECTILES.—A knowledge of the destructive effects of projectiles on iron, wood, earth, and masonry, the materials of which covering masses are made, is of very great importance in a military point of view. In general, these effects, and particularly that of penetration, depend on the nature of the projectile, its initial velocity, and the distance of the object. The following deductions have been made from trials with armor-plates, extending over several years: 1st. The best material to resist projectiles is soft, tough wrought-iron; and to attain these qualities it should be pure—free from sulphur, phosphorus, and carbon. Steely iron, commonly known as homogeneous iron, puddled steel, etc., when in large masses, is easily cracked by shot, and is not, therefore, suitable for armor-plates. Thin plates afford a greater comparative resistance. Soft steel may be used for armor-plates; but when cost is taken into consideration it is doubtful if it possesses any advantages over wrought-iron. 2d. Rolled iron does not offer quite so much resistance as hammered iron, yet if the size of the plate admit of it, it is to be preferred on the score of economy. Plates should be as large as possible to reduce the number of joints, which are lines of weakness. 3d. A solid plate offers, for the same thickness, a greater resistance to a projectile than a laminated one, or one made up of several thinner plates; but when the surface is rounded in shape and of small extent, as in the Monitor turrets, the latter may be used to great advantage, as great thickness of metal may thereby be easily obtained. 4th. The resistance of a plate to perforation is very much increased by a suitable backing. Cast-iron, granite, and brick in masses, while they enable a plate to offer a very great resistance, are soon broken up by the blows of heavy projectiles, and their fragments thrown off with great force. Oak and teak are the most suitable timbers for backing plates, and are used as such on vessels. A yielding backing is found to occasion less strain on the fastenings than a very hard one. 5th. Where projectiles are made of the same material and are similar in shape, their penetration into unbacked plates is nearly in proportion to their *living force*, or *their weight multiplied by the square of the velocity of impact.* The resistance which an unbacked plate offers to penetration is nearly in proportion to the *square of its thickness*, provided this thickness be confined within ordinary limits. In the case of oblique plates the penetration diminishes nearly with the *sine of the angle of incidence.* 6th. The most suitable material for shells to be used against iron plates is tempered steel. These projectiles should be made of cylindrical shape, with thick sides and bottom, to direct the explosive effect of the charge forward after penetration is effected. The most suitable material for solid shot is hard and tough cast-iron. Round shells made of cast-iron will be broken in passing through an inch plate, and an ordinary cast-iron shot will be broken in passing through a two-inch plate. Late experience shows that the pointed, or ogival, is better than the flat form of head for penetration of iron plates. 7th. It follows from the preceding that the most suitable covering or shield for cannon is a conical-shaped turret made of wrought-iron plates, as large as it is practicable to make them, backed with oak or teak. To protect the gunners from the fragments of projectiles which may penetrate completely through this covering, there should be an "inner skin" of thick boiler-plate placed behind the wood.

Effect on Wood.—The effect of a projectile fired against wood varies with the nature of the wood and the direction of the penetration. If the projectile strike perpendicular to the fibers, and the fibers be tough and elastic, as in the case of oak, a portion of them are crushed, and others are bent under the pressure of the projectile, but regain their form as soon as it has passed by them. It is found that a hole make in oak by a ball 4 inches in diameter closes up again, so as to leave an opening scarcely large enough to measure the depth of penetration. The size of the hole and the shattering effect increases rapidly for the larger calibers. A 9-inch projectile has been found to leave a hole that does not close up, and to tear away large fragments from the back portion of an oak target representing the side of a ship of war, the effect of which on a vessel would have been to injure the crew stationed around, or, if the hole had been situated at or below the water-line, to have endangered the vessel. If penetration take place in the direction of the fibers, the piece is almost always split, even by the smallest shot, and splinters are thrown to a considerable distance. In consequence of the softness of white pine nearly all the fibers struck are broken, and the orifice is nearly the size of the projectile; for the same reason the effects of the projectile do not extend much beyond the orifice; pine is therefore to be preferred to oak for structures that are not intended to resist cannon-projectiles, as block-houses, etc.

Effect on Earth.—Earth possesses advantages over all other materials as a covering against projectiles; it is cheap and easily obtained, it offers considerable resistance to penetration, and to a certain extent regains its position after displacement. It is found by experience that a projectile has very little effect on an earthen parapet unless it passes completely through it, and that injury done by day can be promptly repaired at night. Wherever masonry is liable to be breached, it should be masked by earthworks with natural slopes. The size of the openings formed by the passage of a projectile into earth is about one third larger than the projectile, increasing, however,



towards the outer orifice. Rifle-projectiles are easily deflected from their course in earth. They are sometimes found lying in a position at right angles to their course, and sometimes with the base to the front; hence their penetration is variable. Unless a shell be very large in proportion to the mass of earth penetrated, its explosion will produce but little displacement; generally a small opening is formed around an exploded shell by the action of the gas in pressing back the earth. Experience at Fort Wagner showed that it took one pound of metal to permanently displace 3.27 lbs. of the sand of which the fort was made. Time-fuses, being liable to be extinguished by the pressure of the earth, are inferior to percussion-fuses, which produce explosion when the projectile has made about three fourths of its proper penetration. The penetration in earth of the oblong compared to round projectiles, when fired with the service-charges, and at a distance of about 400 yards, is at least *one fourth greater.* This difference, however, is less at short and greater at long distances. The penetration of the smallest: or 3-inch, cannon-projectile, at a disstance of 400 yards, in a newly made parapet of loam mixed with gravel, is about 6 feet. The 100-pdr. projectile, under similar circumstances, penetrates about 16 feet. A penetration as great as 31½ feet has been obtained at the Washington Navy Yard by firing a 12-inch rifle-projectile into a natural clay-bank at a short distance. The greatest penetration of a 15-inch solid shot, fired with 50 lbs. of powder, in well-rammed sand, at a distance of 400 yards, is 20 feet.

Effect on Masonry.—The effect of a projectile against masonry is to form a truncated conical hole, terminated by another of a cylindrical form, as shown in the drawing. The material in front of and around the projectile is broken and shattered, and the end of the cylindrical hole even reduced to powder. Pieces of the masonry are sometimes thrown 50 or 60 yards from the wall. The elasticity developed by the shock reacts upon the projectile, sometimes throwing it back 150 yards, so as to be dangerous to persons in a breaching-battery. The exterior opening varies from 4 to 5 times the diameter of the projectile, and the depth, as we have seen, varies with the size and density of the projectile and its velocity. With charges of ½, ⅓, ¼, and ⅙, a projectile ceases to rebound from a wall of masonry when the angles formed by the line of fire and the surface of the wall exceed 20°, 24°, 33°, 43°, respectively. With these angles, the angle of reflection is much greater than the angle of incidence, and the velocity after impact is very slight. When a projectile strikes against a surface of oak, as the side of a ship, it will not stick if the angle of incidence be less than 15°, and if it do not penetrate to a depth nearly equal to its diameter. Solid cast-iron shot break against granite, but not against freestone or brick. Shells are broken into small fragments against each of these materials.

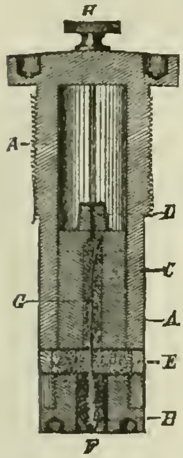
Effect of Bullets.—The penetration of the new breech-loading rifle-musket bullet in a target made of pine boards one inch thick is as follows: at 100 yards, 13 inches; at 500 yards, 9 inches. If bullets are hardened by the addition of a little tin or antimony to the lead, their penetration is very much increased. From experiments made in Denmark, the following relations were found between the penetration of a bullet in pine and its effects on the body of a living horse, viz.: 1st. When the force of the bullet is sufficient to penetrate .31 inch into pine, it is only sufficient to produce a slight contusion of the skin; 2d. When the force of penetration is equal to .63 inch, the wound begins to be dangerous, but does not disable; 3d. When the force of penetration is equal to 1.2 inch, the wound is very dangerous. A plate of wrought-iron three sixteenths of an inch thick is sufficient to resist a rifle-musket bullet at distances varying from 20 to 200 yards. That a rope mantlet may give full protection against rifle-musket bullets, it should be composed of five layers (three vertical and two horizontal) of 4½-inch rope. See *Breaching, Projectiles, Punching,* and *Racking.*

EFFENDI.—A title of honor among the Turks, bestowed upon civil dignitaries and persons of various ranks, in contradistinction to the title of Aga, borne by courtiers and military men. The word is equivalent to the English Sir or the French Monsieur, and is frequently added to the name of an office. Thus, the Sultan's first Physician is termed *Hakim-Effendi;* the Priest in the Seraglio, *Imam-Effendi;* and the Minister of Foreign Affairs was formerly called *Reis-Effendi.*

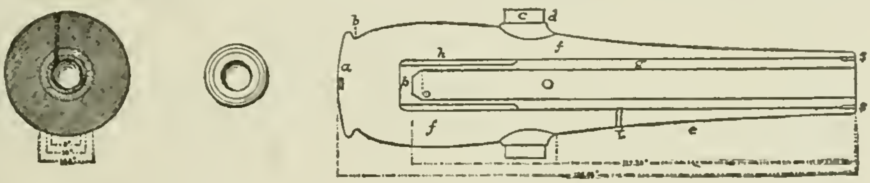
EFFICIENT.—A thoroughly disciplined and capable soldier. It is also a term used in connection with the volunteers. A volunteer is said to be efficient when he has performed the appointed number of drills and fired the regular number of rounds at the target in the course of the year.

EGARD.—An ancient tribunal of Malta which decided, by commission, suits among the Knights.

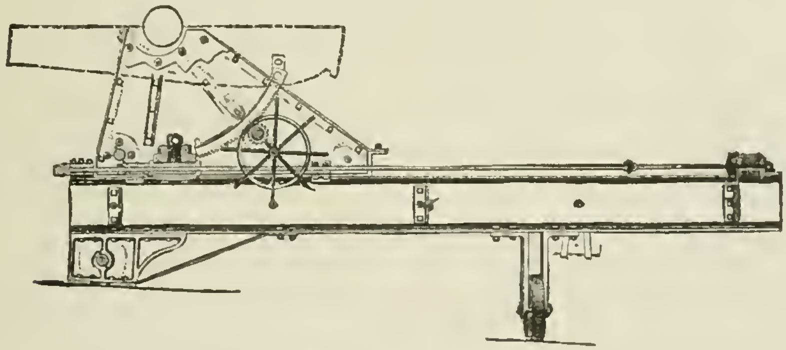
EGGO PERCUSSION-FUSE.—This fuse consists of the stock A, upon the outer surface of the outer part of which is formed a screw-thread, to enable it to be screwed into the shell in the ordinary manner. The outer end of the stock A is made close, with a flange to overlap the seam or joint, and with notches or holes to receive the wrench for screwing it in and out of the shell. The inner end of the stock A is made open and is closed with a screw-plug, B, which is formed with holes or notches to receive the wrench for screwing it in and out. C is the plunger, which is made hollow, and is provided with a nipple, D, at its outer end to receive a cap to cause the shell to be exploded when it strikes, by the forward movement of the plunger C, causing the cap to strike against the closed, outer end of the stock A. The inner end of the stock A is notched or slotted transversely, to receive the ends of the hollow or tubular bar E, with the center of which is connected the inner end of the short tube F. The ends of the bar E may be closed by a paper patch, a slight wooden plug, or other suitable means, to confine the powder until ignited. The outer end of the tube F is flattened, and contains a fulminate to be ignited by friction. The device E F is connected with the plunger C by a wire, G, one end of which is securely attached to the said plunger C, and its other end passes through the tube F. The outer end of the wire G is flattened and roughed or barbed, so that when drawn through the tube F by the forward movement of the plunger C



parts: the *case*, *f*, which is the 10-inch smooth-bore, bored up to a diameter of 13.5 inches, and a *lining-tube* of coiled wrought-iron. The tube consists of two parts, called respectively the A and B tubes. The former extends the entire length of the bore, and contains the rifling; the latter, or B tube, is shrunk upon the inner, or A tube, which has its exterior portion cut away for that purpose. A double tube is thus formed, extending 32.75 inches from the rear end. The two tubes, united in this manner, have the same exterior diameter throughout the entire length, and are made to fit accurately the bore of the cast-iron casing. The bottom of the tube is closed with a wrought-iron cup shaped plug, *p*, screwed into the A tube. The tube is inserted into the casing from the muzzle, and is secured from working out by a muzzle-collar, *s*, screwed in at the face of the piece, and from turning in the casing by a steel pin, *t*, tapped through the casing and into the tube. A shallow and narrow gas-channel is cut spirally around the exterior of the reduced portion of the A tube, communicating with star-grooves cut in the end of the barrel, and with the gas-escape, or *indicator*, bored obliquely through the breech of the casing opposite the vent. Should the inner tube split, under the action of firing, the fact would be indicated by the escape of gas through this hole, and timely warning thus be given of the injury sustained by the gun. The rifling consists of fifteen lands and grooves, each of equal width, viz., .8377 inch. Depth of the grooves, .075 inch.



Eight-inch Rifle.



Carriage for 8-inch Rifle.

it may ignite the fulminate in the said tube F by friction, and thus explode the shell. The screw-plug B has a hole through it to receive the tube F and protect it. H is the safety-pin, which passes in through a screw-hole in the outer, closed end of the stock A in such a position that its forward end may rest against the end of the plunger C at the side of the cap-nipple, and thus holds the said plunger securely in place during transportation and handling, and absolutely secures the shell from being exploded by an accidental blow, shock, or fall. The screw-pin H is removed when the shell is put into the gun and ready to be fired. See *Fuse*.

EIGHT-FOIL.—A term used in Heraldry to signify a grass having eight leaves, as the trefoil has three. According to Sylvanus Morgan, it may be used as the difference of the ninth branch of a family.

EIGHT INCH RIFLE.—This piece, employed in the United States service, is composed, essentially, of two

Twist uniform, one turn in 40 feet. There is no chamber proper to the gun. The rifling stops at a point 10 inches from the bottom of the bore, the diameter of the unrifled portion being equal to that of the rifled portion across lands. The old vent of the case is closed by a wrought-iron screw-plug, and 2.75 inches nearer the muzzle a new one is bored parallel to the vertical plane through the axis of the bore, and distant therefrom 2.5 inches. The axis of the vent enters the bore at 3.5 inches from the bottom.

Length of bore	117.25 inches.
Weight of piece	16,160 pounds.
Counter-preponderance	630 pounds.
Weight of projectile (average)	180 pounds.
Weight of charge (hexagonal powder)	35 pounds.
Initial velocity	1,430 feet.
Pressure upon square inch of bore	33,000 pounds.
Penetration against armor at 1000 yards	7.42 inches.
Penetration against armor at 1800 yards	6.75 inches.

The counter-preponderance is corrected by an eccentric ring of bronze attached to each trunnion.

The following table shows the ranges of this piece, with a charge of 35 pounds hexagonal powder:

Range.	Elevation.	Time of flight.	Angle of fall.	Remain'g velocity.	Drift.
Yards.	° ′	*Seconds.*	° ′	*Ft. sec.*	*Yards.*
100	08	.21	08	1,428	.01
200	16	.42	16	1,406	.03
300	24	.63	25	1,385	.07
400	32	.85	34	1,364	.12
500	41	1.07	43	1,343	.19
600	50	1.29	52	1,323	.28
700	59	1.52	1 03	1,304	.38
709	1 00	1.55	1 03	1,302	.40
800	1 08	1.75	1 14	1,285	.51
900	1 18	1.99	1 25	1,266	.65
1,000	1 28	2.23	1 36	1,248	.82
1,100	1 38	2 47	1 47	1,230	1 00
1,200	1 48	2.72	2 00	1,213	1.21
1,300	1 58	2.97	2 13	1,197	1.43
1,311	2 00	3.00	2 14	1,195	1.46
1,400	2 09	3.22	2 26	1,181	1.68
1,500	2 20	3 48	2 41	1,165	1.95
1,600	2 31	3.71	2 56	1,149	2.25
1,700	2 42	4.00	3 11	1,131	2 56
1,800	2 53	4.27	3 26	1,120	2.90
1,863	3 00	4.44	3 33	1,111	3 12
1,900	3 04	4.54	3 41	1,106	3.25
2,000	3 16	4.81	3 56	1,093	3.65
2,100	3 28	5.09	4 13	1,080	4.06
2,200	3 40	5.37	4 30	1,067	4.50
2,300	3 52	5.65	4 47	1,056	4.96
2,365	4 00	5.83	4 57	1,049	5.28
2,400	4 04	5.94	5 04	1,045	5.45
2,500	4 16	6.23	21	1,035	5.95
2,600	4 30	6.52	5 40	1,025	6.53
2,700	4 44	6.81	5 59	1,016	7.13
2,800	4 58	7.11	6 18	1,008	7.76
2,817	5 00	7.06	6 21	1,007	7.86
2,900	5 12	7.41	6 37	1,000	8.41
3,000	5 26	7.71	6 56	992	9.09
3,100	5 40	8.01	7 17	985	9 80
3,200	5 55	8 32	7 38	978	10.56
3,243	6 00	8.51	7 46	974	10.85
3,300	6 10	8.63	7 59	971	11.35
3,400	6 25	8.94	8 20	961	12.16
3,500	6 40	9.25	8 41	957	13.01
3,600	6 55	9.56	9 02	951	13.88
3,643	7 00	9.70	9 11	948	14.21
3,700	7 10	9.88	9 23	941	14.78
3,800	7 26	10.20	9 46	938	15.74
3,900	7 42	10.52	10 09	932	16.73
4,000	7 58	10.84	10 32	926	17.75
4,017	8 00	10.90	10 36	925	17.90
4,100	8 14	11.16	10 55	920	18.80
4,200	8 30	11.49	11 18	914	19.87
4,300	8 46	11.82	11 41	909	20.98
4,377	9 00	12 08	12 01	904	21.92
4,400	9 04	12 15	12 04	903	22.20
4,500	9 22	12.48	12 29	898	23.41
4,600	9 40	12.82	12 54	892	24.73
4,700	9 58	13.16	13 19	887	26.04
4,723	10 00	13.26	13 26	885	26.25

It has been found that the 10-inch carriage, upon which this piece is mounted, is not sufficiently stout to stand many discharges with a charge of 35 pounds. Charges of 25 pounds will penetrate any wooden ship at ordinary ranges, but are of no effect against ironclads. The carriages will stand this charge without serious damage.

The four varieties of carriages upon which these pieces are mounted are those altered from the 10-inch barbette-gun carriage, and thus far are only experimental. Carriages Nos. 1 and 2 have friction-bars for checking recoil. Nos. 3 and 4 have hydraulic cylinders for the same object. Nos. 3 and 4 have a geared windlass, with cranks and handles, attached to the rear part of the chassis. Nos. 1 and 2 are without windlass. No. 1 is distinguished from No. 2 by the absence of the ratchet-post, and by having, instead, for elevating, a circular toothed arc operated by a hand wheel and pinions upon the left cheek of the carriage. No. 2 has the ratchet-post, but not a toothed arc. Carriage No. 3 is distinguished from No. 4 by having a wedge-shaped incline bolted to the top of each rail of the chassis, near the rear end, and by having a hand-lever on the outside of each chassis-rail, for the purpose of uncoupling the top-carriage from the chassis. See *Converted Guns.*

EIGHT-INCH SIEGE-MORTAR.—This mortar, used in the United States service, is made of cast-iron, has a smooth bore, and is without chamber. The following tables show the weights, dimensions, and ranges pertaining to the piece:

Designation.	No.	Lbs.	Inch.
Caliber	......	......	8
Weight	......	1010	......
Preponderance	......	00	......
Length of piece	......	......	22
Length of bore (calibers)	2	.....	......
Windage	......	......	.12
Charge (maximum), mortar-powder	... ..	2.25	......
Weight of shell (empty)	......	46	......
Charge to fill shell, musket-powder	......	2.5	......
Charge to blow out fuse-plug	......	.25	......
Weight of carriage	......	900	......
Weight of carriage, mortar, and implements	......	1965	......
(One mortar-wagon will carry three mortars, with their carriages.)			

RANGES.

Charge.	Elevation.	Range, yards.		Time of flight, Seconds.	
Ounces.	Degrees.	Shell,52 lbs	Shell,46 lbs	Shell,52 lbs	Shell,46 lbs
8	45	399	433	9.50	9.65
12	45	717	727	12.45	12.50
10	45	955	1029	14.85	15
14	45	1265	1275	16.50	16.80

EIGHTY-TON GUN.—A large Woolwich gun designed as an armament for the "Inflexible." When first made it weighed 81 tons, having a caliber of 14½ inches. It was bored during the progress of the experiments to 16 inches, and was given an enlarged chamber. The experiments were conducted by the well-known and celebrated "Committee on Explosion." See *Ordnance.*

EISENHUT.—An iron hat or helmet, without vizor or neck-guard, but supplied with a rim. It was first worn in the twelfth century, and remained in use until the seventeenth century.

EJECTOR.—The device commonly used in breech-loading small-arms to throw out the metallic cartridge-case after it is fired. The ejector-spring operates the ejector. See *Springfield Rifle.*

ELASTICITY.—When an external force acts upon a solid body, it produces at first slight alterations in the relative positions of the particles; and if before these alterations exceed a certain limit the force ceases to act, the particles return to their former position and the disfigurement disappears. This power or property of recovering their previous form after alteration is called *elasticity;* and we are justified in ascribing it to all bodies, though in very different degrees. It was once believed that there were definite limits within which changes of form produced by pressure or other forces disappeared completely. It was thought, for instance, that when a weight of no great magnitude is suspended from a metallic wire, the slight increase of length which the wire is observed to undergo is completely lost when the weight is removed; and the limit to which the wire might thus be stretched and still suffer no permanent increase of length was called the limit of its elasticity. But recent more accurate experiments have shown that no such limits exist, at least in the case of metals; or, which is the same thing, that permanent lengthening results, however slightly the wire be loaded—it never contracts again quite so far as it was stretched. It is necessary, therefore, to fix the limit arbitrarily; and this is done by agreeing that it shall be held to begin when the metal in question suffers a permanent elongation of .00005 of its length. To get the elastic extensibility of a wire, then, we must compare its length suspended with its length when the weight is removed. In this way it is found that the extensions produced are proportional to the extending forces or weights. From this law, then, we can calculate what weight it would require to stretch a wire or rod of a square inch in section to double its own length; supposing it possible to proceed so far without breaking it, and that the law of elasticity continued up to this point unaltered. This weight, which is different for every metal or kind of wood, is called the *coefficient* or *modulus of elasticity* of the particular substance; and is used in mechanics in calculating how far a given weight will extend a wire or rod of given diameter. This coefficient is not constant for the same metal; for all circumstances that increase the density of the metal increase the modulus of elasticity. Bodies manifest elasticity not only when extended in length, but also when compressed, when bent, or when twisted. If an ivory ball be dropped from a height upon a marble slab smeared with fat and lamp-black, when caught after the rebound, it is seen to have touched the marble, not in a point, but in a circle of several lines in diameter, and must therefore have lost for a time its spherical shape over that extent. In the same way the mark of a well-hit golf-ball is pretty broadly shown upon the face of a club after the stroke. The elasticity shown by wires and threads of glass when twisted has been turned to account in the torsion-balance used for measuring other weak forces. Steel, ivory, caoutchouc, etc., are well known for their elastic properties, to which they owe much of their utility.

ELASTIC PRESSURE.—Cannon are subjected by the pressure of powder to the following strains: *tangential*, *longitudinal*, *transverse*, and *strains of compression*. If p be the pressure on a unit of surface of the bore, and s the tensile strength of the metal, it can be shown by analysis that the tendency to rupture, or the pressure on a unit of length of the bore, divided by the resistance which the sides are capable of offering to rupture, for a piece of one caliber thickness of metal, will be as follows, viz.:

$$\text{Tangential, } \frac{3p}{2s};$$

or, rupture will take place when three times the pressure is greater than twice the tensile strength.

$$\text{Longitudinal, } \frac{p}{2s};$$

or, rupture will take place in the direction of the length when the pressure is greater than twice the tensile strength.

$$\text{Transverse, } \frac{2p}{3s};$$

or, rupture will take place when twice the pressure is greater than three times the tensile strength. From the above it appears that the tendency to rupture is greater from the action of the tangential force than for any other; and for lengths above two or perhaps three calibers the tangential resistance may be said to act alone, as the aid derived from the transverse resistance will be but trifling for greater lengths of bore or stave; but for lengths of bore less than two calibers this resistance will be aided by both the transverse and the longitudinal resistance. Every piece should, therefore, have sufficient thickness of breech to cause rupture to take place *laterally*, if at all, instead of splitting through the breech.

The most obvious means of enabling any vessel to sustain a greater elastic pressure is to simply thicken its sides, thus increasing the area of substance to be torn asunder. But to obtain much greater strength by casting guns heavier is impossible, because in cast guns the outside helps but very little in restraining the explosive force of the powder tending to burst the gun, the strain not being communicated to it by the intervening metal. The consequence is that, in large guns, the inside is split, while the outside is scarcely strained. This split rapidly increases, and the gun ultimately bursts. If we make equidistant circular marks on the end of an India-rubber cylinder and stretch it, we can see plainly how much more the inside is strained than the outside, or even the intermediate parts. The spaces between the marks will become thinner, each space becoming less thin than that inside of it, but the inner space much thinner than the others, showing that when the inside is strained almost to breaking, the intermediate parts are doing much less work, and those far removed almost none. It is well known that *in cylinders of metal the power exerted by different parts varies inversely as the squares of the distances of the parts from the axis.* Thus, in a 10-inch gun, when the inside, which is 5 inches from the axis, is fully strained, the metal 2 inches from the inside, or 7 inches from the axis, can only exert a force $\frac{25}{49}$, or little more than half, as much. We cannot, therefore, be astonished that it has been found in practice that cylinders for hydraulic presses, with a thickness equal to about one half the diameter of the piston, are almost as strong as if ten times as thick. Hence there is a certain limit beyond which it seems useless to increase the thickness of the metal, and this is when the force exerted on the surface of the bore would be sufficient to rupture the interior portions of the metal before the strain acted to any extent upon the exterior parts. Any arrangement of the parts by which the explosive strain is distributed equally over the entire thickness of the piece necessarily brings a greater amount of resistance into play. In order to obtain the requisite resistance, and with a moderate thickness of metal, it is desirable to equalize as far as possible the strain upon every portion of the metal. There are two methods of accomplishing this, depending upon the principles of *initial tension* and *varying elasticity*. Some gun-makers use the one, some the other, and some a combination of the two. See *Initial Tension* and *Varying Elasticity*.

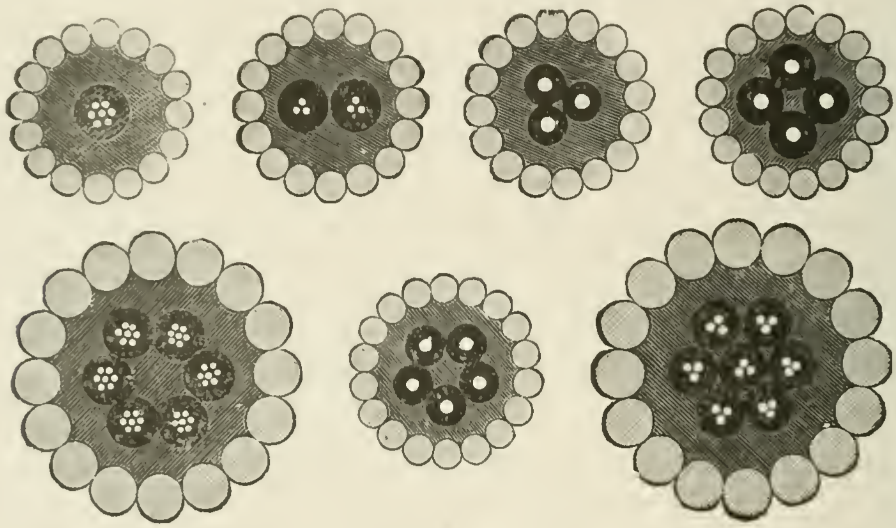
ELBOW-GAUNTLET.—An ancient piece of armor, a gauntlet of plate reaching to the elbow, adopted from the Asiatics in the sixteenth century.

ELBOW-PIECES.—The metal plates used to cover the junction of the rere-brace and vant-brace, by which the upper and lower half of the arm were covered. They increased to an enormous size, as in the effigy of Sir Thomas Peyton, in Isleham Church, but again decreased to their normal size. Also written *Condières*. See *Armor*.

ELECTRIC BOMB-LANCE.—An application of the electric force to the explosion of a bursting-charge in a harpoon or bomb lance. A copper wire is carried through the line, and, when a circuit is established by the gunner, a resistance-section in the fuse of the bomb-lance ignites the charge.

ELECTRIC CABLES.—Electric cables for military use must possess the following qualifications: 1. Capacity to sustain a certain amount of strain without breaking. 2. Good insulation, composed of such a substance that it may be readily stored and kept for a considerable time without being injured. This is essential, as the lines will only be submerged while actually in use in time of war, for which purpose they must consequently be kept in store, and always ready in sufficient quantities. 3. For situations where there is a rocky or shingly bottom, they must be provided with an external covering capable of protecting the insulation from destruction. Special precautions must, of course, be taken to secure the cables at points where they may be necessarily exposed to a considerable wash of the sea, such as the places where they may be led into a fort, etc.; but as there are others where no such special precautions can be applied, an external protecting covering over the insulation must be provided. 4. Pliability, so that it may be wound or paid out from a moderately sized drum without injury. The conducting wire is either soft iron or copper. The best substance for covering it to effect insulation is vulcanized India-rubber, as it can stand any degree of heat likely to occur to a cable, and does not harden and crack as does gutta-percha. The conductor should, however, be galvanized and covered with a thin coating of raw India-rubber, to protect it from the action of the sulphur of the vulcanized rubber. India-rubber insulation possesses one defect as compared with gutta-percha; viz., that it does not adhere to the metallic conductor, and that, consequently, if the India-rubber is once cut through, any strain on the cable has a tendency to pull the conductor away and increase the fault. This does not occur with gutta-percha, which seems to cling to it and prevent such a result. Gutta-percha cracks and perishes unless considerable care is exercised in preserving it, which is best done by keeping it under water. India-rubber possesses higher dielectric properties than gutta-percha.

The Bishop gutta-percha cables and insulated wires, manufactured under the Simpson patent by Messrs. L. G. Tillotson & Co., United States, are in most cases used for submarine mines. The drawings show sections of one, two, three, four, five, six, and seven conductors. These multiple cables are in many cases found convenient where it is required to carry a large number of wires in a compact form into a fort. They may be composed of any suitable number of distinct cores, each of which consists of a strand of copper or iron wire insulated with rubber or gutta-percha. Where there is any strain, or any chance for abrasion against rocks or gravelly bottom, an exterior covering is necessary for protection. Frictional electricity must not be used with the cables, as it would be nearly certain that every mine attached to the cable would explode by induction. See *Galvanometer* and *Submarine Mines*.

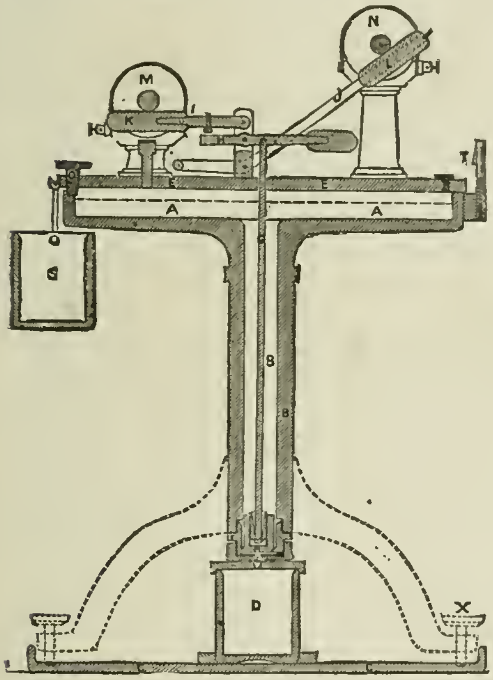


Gutta-percha Multiple Cables.

ELECTRIC CLEPSYDRA.—Generally, with chronometric instruments, the time is deduced from the space passed over during the interval to be measured by a body which moves according to a determined law. This moving body, which we call "chronometer," is the important part of the apparatus; the other fittings are but accessories serving to put the chronometer in operation; that is to say, to render it capable of marking the commencement and the end of the time to be measured. The choice of chronometer, then, is of first importance. A weight falling freely constitutes, incontestably, the most simple and most exact chronometer; regulated by an immutable law of nature, its motion is accomplished without the aid of any intermediary force; neither use nor time can alter its rate; it is absolutely invariable. Unfortunately this chronometer is only applicable to the measure of times relatively short, for the extent of fall increases with the time in very rapid proportions. One can, it is true, transform the vertical fall into a movement of rotation, whether continuous, such as that of revolving cylinders, or alternate, such as that of pendulums; but in both cases the great advantage of a constant chronometric movement is lost; account must then be taken of friction, and this may be varied by causes which escape the observation, and certainty and reliability in the result no longer exist. In order to avoid this inherent inconvenience in the employment of such a mechanical instrument, we may employ as a chronometer the flow of a liquid, and determine the time by means of the weight run out during the interval to be measured. For this purpose mercury presents itself naturally to the mind; this metal, very fluid and homogeneous, has great specific weight, its evaporation is insensible, and, not moistening the inclosing surfaces, its use is extremely clean and convenient. This has been done by Major Le Boulengé of the Belgian Artillery in an instrument to which he has given the name of *electric clepsydra*.

The instrument, represented in section in the drawing, is composed of a circular reservoir, A, of $0^m.20$ diameter by $0^m.03$ high, containing mercury, and supported by a hollow central column, B, of $0^m.20$ height, terminating in a tripod fitted with leveling-screws, X. This vessel, of cast-iron, rests on a circular plate, C, of the same metal, which is fitted with a rim to catch the mercury which may through inadvertence flow out of the receiver, D. A disk of cast-iron, E, covers the reservoir and bears the electrical fittings of the apparatus. The hollow column, which makes a part of the receiver, terminates at the lower end in a fine orifice, above which is fitted a conical valve which prevents the mercury from running out. The face of the orifice, the body of the valve, R, and its seat, F, are of steel. A rigid stem, G, connected by a swivel-joint to the body of the valve, rises, following the axis of the receiver, traverses a central opening in the upper disk, and then connects above this latter to a horizontal lever, H, which is called the valve-lever. If the arm of this lever opposite to the connection of the stem be pressed down, the valve is opened and flow is produced. If the effort be discontinued, the valve falls back upon its seat and the flow is arrested instantaneously. The opening and closing of the valve are performed by the action of two levers, I and J, which fall successively, and of which the heavier extremities, fitted with armatures of soft iron, K and L, are held in the state of "ready" (shown in the figure) by electro-magnets, M and N.

The lever for closing is formed of two parallel arms, united at one end by the armature, at the other by a cross-piece used to raise the lever, K; this disposition permits it to move without touching the valve-lever. If the current which actuates the electro-magnet, M, be broken, the opening lever falls upon the end of the valve-lever, opens the valve permanently, and the mercury flows into the receiver, D, placed immediately under the orifice. We call the lever K, opening-lever; its magnet current and circuit will be called by the name of electro-magnet current and circuit of opening, to distinguish them from similar fittings which operate the closing. If the second current be broken, the closing-lever falls in turn, raises the opening-lever to its original position; then the lever of the valve being freed, this latter falls back into its seat and the flow is arrested. A catch, T, prevents vibration of the closing-lever after its fall. This simple combination of three levers fulfills perfectly the mechanical conditions imposed, for the valve opens suddenly by a shock, while it closes freely by its own action. In actual practice the two currents are bro-



ken successively by the projectile; a weight, P', of mercury flows into the receiver, and it is required to deduce from it the period which has separated the two ruptures.

Let us suppose for a moment that the apparatus furnishes a constant flow, and let P be the flow of the orifice, that is, the weight of mercury which flows per second; by dividing P' by P the time is obtained which has elapsed between the instant of opening and that of closing the value.

The relation $\frac{P'}{P}$ will also give the time which has elapsed between the rupture of two currents, if the valve has opened and closed at the precise instant of the rupture of the corresponding current. But this is not the case; when the first current is broken, a certain time is necessary in order that the magnet may arrive at such a state of demagnetization as to release the armature, then a certain time for the fall of the lever, and finally an additional time for the complete raising of the valve. Analogous periods transpire between the rupture of the closing current and the arrest of the flow. The determination of these short periods is obviated by applying to the instrument the method of simultaneous disjunction, the important feature of which has been devised by Major Navez. To this end the fall of the levers is regulated in such a way that the opening-lever occupies less time than the other from the commencement of its fall to its action on the valve. Thus, when by means of a disjunctor both currents are cut at the same time, the first lever opens the valve a certain time before the second closes it; the weight, P, of mercury run out in this way is the precise quantity to be deducted from P' in order to ascertain from the expression $\frac{P'-p}{P}$ the time which has elapsed between the rupture of the two currents.

This method of procedure takes into account both the time lost in the working of the mechanism and that of demagnetization, which varies with the respective force of the two currents. See *Chronoscope*.

ELECTRIC CLOCK.—A dial with hands and going-train impelled by recurrent impulses from an electro-magnet. The regularity of any clock depends, as is well known, on the action of the pendulum, which is isochronous—that is, has the property, within certain limits, of describing long and short arcs in the same time. The pendulum, however, left to itself, would, in consequence of the resistance of the air, and of the spring on which it hangs, soon come to rest. An impulse must therefore be given it occasionally to keep it going. This impulse need not necessarily be exactly the same, for though it might cause the pendulum to make a longer swing at one time than at another, the time of oscillation would not differ. In ordinary clocks these impulses are given by a heavy weight, and are transmitted to the pendulum through the wheel-work of the clock. No moving power can be more steady than gravity, or less likely to tax the isochronism of the pendulum, but its action on the clock is limited by the distance through which the weight descends, so that the weight must be periodically wound up to preserve gravity in play. The trouble of winding, though small, still leaves room for the wish that a clock might be constructed going for long periods without external help. Such an instrument the electric clock professes to be; but an independent electric clock is not trustworthy as a timekeeper, and all that electric clocks are used for is to copy the time of a good gravity clock. This work the electric clock does to perfection. The electric clock was invented by Bain, an Edinburgh clockmaker, in 1840, and his ideas, though improved and modified, still form the basis of electric-clock-making. In the ordinary clock it is the clock that moves the pendulum; in Bain's clock it is the pendulum that moves the clock. As the construction of the pendulum is the only part of it connected with electricity, we shall confine our notice to a general description of the pendulum action. To the lower part of the pendulum a bob is attached, consisting of a hollow bobbin of insulated copper wire. Wires from both ends ascend the pendulum-rod, and are in metallic connection respectively with the two springs from which the pendulum hangs. Two magnets, or bundles of magnetic rods, are fixed at either side of the bob, and are of such dimensions that the hollow bob in its oscillation can pass a certain way over each without touching. The magnets have their like poles turned towards each other. The two springs of the pendulum-rod are in connection with the two poles of a galvanic battery. The wire connecting one of them is made to pass round by a break, worked by the pendulum-rod. When the pendulum is made to move, say towards the right, it shifts a slider, so as to complete the connection between the poles of the battery. The current thereupon descends one of the wires of the pendulum, passes through the coil of wire forming the bob, and ascends by the other. So doing it converts the bob into a temporary magnet, the S. pole towards the right and the N. pole towards the left. In this way the S. pole of the bob is repelled by the S. pole of the right-hand magnet, and its N.

pole is attracted by the S. pole of the left-hand magnet, so that from this double repulsion and attraction, both acting in the same direction, the bob receives an impulse towards the left. Partly, therefore, from this impulse, and partly from its own weight, the pendulum describes its left oscillation; and when it reaches the end of it, it moves the slider so as to cut off the battery current, and then returns towards the right, under the action simply of its own weight. On reaching the extreme right, as before, it receives a fresh impulse, and thus, under the electric force exerted during its left oscillation, the motion of the pendulum is maintained. So long as the electricity is supplied will the pendulum continue to move. The current required is exceedingly weak, and Bain considered that it could be sufficiently excited by a plate of copper and a plate of zinc sunk into the ground and acted upon by the moisture usually found there. This earth-battery, as he called it, was expected to act steadily for years; but the result proved far otherwise, for the soil not unfrequently dried up, leaving no trace of electrical action. The imperfection of the battery has led to a strong prejudice against these clocks—stronger, certainly, than they merit. Practice has, however, established that a clock driven by an electric pendulum, under no control, is not to be trusted, and clocks of this kind, so far at least as this country is concerned, are entirely abandoned. The next important step in perfecting the electric clock was made by Lewis Jones (patented 1857). All his clocks are ordinary gravity clocks. The standard clock is not an electric clock at all, but its pendulum makes and breaks contact in the battery-circuit which controls the copying clocks. These last, though driven by weights, have Bain's pendulums, and the currents transmitted by the standard clock keep them oscillating in exact accordance with it, so that the standard clock and copying clocks have their pendulums always at exactly the same point in their oscillations. The copying clocks are adjusted to keep nearly the time of the primary, and the margin of error is wholly removed by electric control.

ELECTRIC FUSES.—In most blasting or mining operations the use of galvanic batteries or electrical machines, together with proper exploders, has almost entirely superseded that of the various forms of running fuse. Among the advantages offered by the application of electricity to this purpose may be mentioned: greater ease of application, more complete control, and greater safety; the power to obtain a practically simultaneous explosion of a number of charges, and the ability to work at greater distances, as in torpedo operations. Electric fuses may conveniently be divided into two classes: 1st. Those in which explosion is obtained by disruptive discharge between two points in the circuit. 2d. Those in which the explosion is determined by the heating of a conductor of comparatively high resistance introduced into the circuit.

The first class can be used with the Leyden-jar induction-coil, or any frictional electrical machine, such as Smith's or Von Ebner's, and are known as *frictional fuses*. Fuses of this kind are made in a variety of forms, but in all essential features are alike. All that is necessary is that there shall be a break in a circuit not greater than a spark can easily be made to pass over (generally from $\frac{1}{8}$ to $\frac{1}{16}$ inch), and that between the points of this break shall be placed some composition that will be ignited by the passage of the spark. Gunpowder can be used, but does not ignite readily, and for this reason some more sensitive composition is generally employed. The objections to this class of fuse are: 1st. The highly sensitive compositions used render them dangerous. 2d. Perfect insulation of all leading wires used in connection with them is necessary, particularly when working under water or in damp places. 3d. The frictional machines used with these fuses require great care to keep them in working order, and are much affected by atmospheric causes.

The second class of electric fuses may be further divided into two sub-classes: 1st. *Magneto-electric fuses*, or those in which the introduced or secondary conductor is a substance of high specific resistance, such as plumbago, copper sulphide, or Abel's composition. 2d. *Dynamo-electric fuses*, or those in which the secondary conductor has a comparatively low resistance, such as fine platinum, iron, or German-silver wire.

The magneto-electric fuses are used with Wheatstone's, Beardslee's, and similar machines. The fuse consists essentially of a break in a circuit which is bridged by a layer of plumbago or composition, which, when heated by the passage of the current, burns and ignites the charge of the fuse. These fuses are always of high resistance, but are, however, safe, owing to the fact that no very sensitive composition is used in their construction; but those of the same manufacture vary greatly, both in resistance and the strength of current required to fire them. The principal objections to this class of fuse are: 1st. The great resistance of the fuse makes perfect insulation of all leading wires used in connection with them necessary, for any defect of insulation, particularly when working under water, would probably offer less resistance to the passage of the current than the fuse itself, and the greater part of the current would thus be diverted from the fuse. 2d. Their unavoidable lack of uniformity in resistance and strength of current required to fire them. 3d. Their liability to be rendered worthless by the displacement of the plumbago, from handling or other causes.

The essential feature in the construction of all fuses of this class is the introduction in a circuit of a fine metallic wire, which, when heated by the passage of a current, fires the priming material, or in some instances the charge of the fuse itself, placed in contact with it. These fuses are generally of low resistance and require a moderately strong current to fire them; and by care in construction great uniformity in resistance can be obtained, and much greater regularity in the strength of current required to fire them than with the other classes. The principal advantages of this class of fuse are: 1st. Uniformity. 2d. Safety. 3d. Owing to their low resistance, moderate defects of insulation will not prevent the firing of the fuse. 4th. The condition of the fuse (even after it has been placed in the charge) can always be safely tested by the passage of a weak current, and the certainty of firing be thus demonstrated. 5th. The fuse is not likely to be damaged by handling, storage, or transportation. 6th. The machines used in connection with them require but little care and are not likely to get out of order.

Platinum may be dispensed with by bringing the ends of the conducting wires so close together as barely to be apart, thus forming a break or interval in the conductor. The ends of the wire are held in exact position, usually by being passed through a short plug of wood. Around this plug is wrapped paper, which, projecting at the end where the conductor is broken, forms an envelope for the priming. This wrapping or cap is afterwards covered with a strong shellac varnish. When regularly manufactured fuses cannot be obtained, it may become necessary to improvise them. This may be done in several ways, one of which is to take a small cylinder of hard wood about an inch in diameter and half an inch long; this is provided with a groove around its circumference, in which is tied the paper envelope before mentioned. Two holes about a quarter of an inch apart and of suitable size to receive two moderately fine pieces of copper wire are made lengthwise through the cylinder. One extremity of both of these wires is sharpened with a file, and about a quarter of an inch of the wire bent over at right angles, and slightly flattened with a hammer, the extreme point being bent over in the form of a hook. The straight ends of the wire are then passed through the holes in the cylinder, and the flattened heads are fixed in the wood

ELECTRICITY. 1. Galvani's experiment on frogs' legs. 2. Dry pillar. 3. Electrical "perpetual motion." 4. [illegible]ectroscope. 6. Galvanic element. Cups or cells. 8. Bunsen's column. 9. Generation of heat by galvanic current 10. Galvanic incandescence. 11, 12. Galvanic light. 13, 14. Decompos[illegible] by galvanic current. 15. Voltameter. 16. Electrolysis of saline solutions. 17. Galvano-plastic. 18. Oersted's fundamental experiment. 19. Tangent-bussole. 20. Multiplier. 21. Magnetic coil. [illegible] magnetic polarity. 23, 24. Electro-magnets. 25 to 27. Electric telegraph (25, sounder and strip with Morse or Graham alphabet; 26, key; 27, circuit complete; s, key; m, sounder; b, battery; p, ground-[illegible] Electro-magnetic motor. 30. Electro-dynamic test. 31. Solenoid. 32, 33. Ampère's theory of magnetism. 34. Electro-dynamic attraction. 35, 36. Thermo-electric elements. 37, 38. Thermo-elec[illegible] Electro-magnetic machine. 40. Induction apparatus. 41. Rumkorff's spark inductor. 42. Electric abater. 43. Ground inductor. 44, 45. Diamagnetism.

by driving the pointed extremities into the latter. In this way the broad, thin metal surfaces which form the poles of the fuse are fixed in a parallel position on the surface of the wood, and should be as close together as possible without actually touching. Before, however, the wires are thus placed in position, the surface of the cylinder, upon which the poles are to be fixed, is brushed over lightly with a solution of ordinary photographic collodion. When the poles have been fixed into the cylinder thus prepared, the small surface of wood which intervenes between them is coated with graphite by drawing a pointed black lead pencil across it two or three times. A cap of paper is then tied round the cylinder so as to inclose the poles of the fuse; this cylinder is filled compactly with fine gunpowder, and the open end is then choked. The protruding wires of the fuse, which serve to connect it with the conducting wires, are coated to within a short distance of their extremities by molding ordinary beeswax around them with the fingers, and then tightly wrapping the wax with thin strips of tape or rag, which is secured to the ends with thread. The entire fuse, except the bare ends of the wires, is then coated with shellac or lacquer. This fuse may be fired by means of a constant battery of sufficient power, or by a magnetic exploder, the former of which generates a continuous current, and the latter a rapid succession of short currents. Currents of this character are required to produce the heating power over the plumbago bridge necessary to ignite the priming. See *Dynamo-electric Igniter*, *Fuse*, and *Galvanism*.

ELECTRICITY.—The name used with reference to an extensive and important class of phenomena, and usually denoting either the unknown cause of the phenomena or the science that treats of them. Most of the phenomena in question fall under the three chief heads of frictional electricity, galvanism, and magneto-electricity. The present article is confined to the first. Thales, about 600 B.C., refers in his writings to the fact that amber, when rubbed, attracts light and dry bodies. This was the only electric fact known to the ancients. The science of electricity dates properly from the year 1600 A.D., when Gilbert of Colchester published a book, entitled *De Arte Magnetica*, in which he gives a list of substances which he found to possess the same property as amber, and speculates on magnetic and electric forces. He is the inventor of the word electricity, which he derived from the Greek word *electron*, amber. Otto von Guericke, Burgomaster of Magdeburg, in his work *Experimenta Nova Magdeburgica* (1672), describes, among his other inventions, the first electric machine ever made, which consisted of a globe of sulphur turned by a handle, and rubbed by a cloth pressed against it by the hand. Hawksbee (1709) constructed a machine in which a glass cylinder, rubbed by the dry hand, replaced Guericke's sulphur globe. Grey and Wehler (1729) were the first to transmit electricity from one point to another, and to distinguish bodies into conductors and non-conductors. Dufay (1733–45) showed the identity of electrics and non-conductors, and of non-electrics and conductors, and was the first to discover the two kinds of electricity, and the fundamental principle which regulates their action. Between the years 1733 and 1744 much attention was given in Germany to the construction of electric machines. Up to this time, notwithstanding the inventions of Guericke and Hawksbee, the glass tube rubbed by a piece of cloth which Gilbert first introduced was used in all experiments. Boze, a Professor at Wittenberg, taking the hint from Hawksbee's machine, employed a globe of glass for his machine, and furnished it with a prime conductor. Winkler, a Professor at Leipsic, was the first to use a fixed cushion in the machine. The Leyden jar was (1746) discovered accidentally at Leyden by Muschenbroek; but the honor of the discovery has been contested also in favor of Cuneus, a rich burgess of that town, and Kleist, Canon of the Cathedral of Camin, in Pomerania. Franklin (1747) showed the electric conditions of the Leyden jar, and (1752) proved the identity of lightning and electricity by his famous kite experiment. The last was performed with the same object about the same time, and quite independently, by Romas of the town of Nerac, in France. In 1760 Franklin made the first lightning-conductor. Canton, Wilke, and Æpinus (1753–59) examined the nature of induction. Ramsden (1768) was the first to construct a plate-machine, and Nairn (1780) a two-fluid cylinder-machine. The electrophorus was invented by Volta in 1775, and the condenser by the same electrician in 1782. In 1786 Galvani made the discovery which led to the addition of the new branch to the science which bears his name, and which now far exceeds the older branch in extent and practical value. In 1787 Coulomb, by means of his torsion-balance, investigated the laws of electric attraction and repulsion. In 1837 Faraday published the first of his researches on induction. Armstrong, in 1840, designed his hydro-electric machine.

Under the head CONDUCTORS it is stated that bodies which do not conduct electricity, or non-conductors, are capable of electrical excitation from friction, and are in consequence termed electrics, and that conductors not so affected are called non-electrics. The *fundamental principles* of electricity are illustrated by the *electric pendulum*. A glass tube bent at right angles, so as to project horizontally, is placed on a convenient stand. On the hook in which its upper end terminates, a cocoon thread is hung, to the end of which a pith-ball is attached. The ball is thus doubly insulated by the glass and the silk thread. If a tube of glass be rubbed by a dry silk handkerchief, and brought near the ball, the ball is at first briskly attracted, and then as briskly repelled; and if the tube be then moved towards it, it moves off, keeping at the same distance from it. The ball being so affected, or charged, as it is called, a rod of shellac or of sealing-wax, after being rubbed with flannel, attracts it, if possible, more briskly than before, and again sends it off exactly as the glass had done. If the glass tube be now again taken up and rubbed a second time, if necessary, the ball will act towards it as it did towards the sealing-wax. The same series of attractions and repulsions would have taken place if we had begun with the sealing-wax instead of the glass tube. We interpret this experiment in the following way: When glass is rubbed with silk, and the silk removed, it is charged with what is called positive electricity. The ball is attracted by it, and becomes on contact also charged with positive electricity, and is then repelled. When sealing wax is rubbed with flannel, and the flannel removed, it becomes charged with negative electricity, which is the counterpart of positive electricity, for it attracts the positively charged ball, and, communicating its own electricity to it, finally repels it. From such an experiment as this we conclude *that bodies electrified either positively or negatively attract neutral bodies and bodies affected with electricity of an opposite name to their own, but repel those affected with electricity of the same name; and that electricity can be communicated from one body to another by contact.* For positive and negative (written also + and −), the terms vitreous and resinous are also employed, as glass and resin are the typical substances from which they may be obtained. Contact is not the only way in which electricity is communicated. We find, when we deal with larger bodies than the pith-ball of the experiment, and sometimes even with it, that the passage of a *spark* between two bodies without contact communicates the electricity of the one to the other. The part played by the rubbers in the above experiment must not be overlooked. The silk handkerchief employed to rub the glass assumes the resinous or − electrical state, and the flannel rubber of the sealing-wax the vitreous or +. This cannot, however, be clearly shown as the experiment is performed, for the rubbers are in each case tightly embraced by the hand, which neutralizes their peculiar electricity. We can perform our fundamental experiment in a way clearly to show this. Let us take for our rubbing and rubbed surfaces two India-rubber balloons inflated with air (such as children play with), and hold them tightly one in each hand. They may be in all respects perfectly alike. Let us then rub them briskly on each other, and then hold the rubbed sides closely together. On bringing the two in contact near the pith-ball, it remains indifferent to them; but if we pull them apart, and put one on each side of the pith-ball, the ball plays actively between them, being attracted and repelled by each in turn. The fact of no attraction occurring when the balloons are together shows that in the rubbing both electricities are generated in equal quantities, for they neutralize each other when brought near; and the fact that the balloons must be separated proves that all electric phenomena take place in an electric field, with positive electricity at its one termination, and negative electricity at its other. The non-conducting nature of the India-rubber prevents the electricities finally neutralizing in contact, and disappearing by the hands when apart. It is also instructive that as force is exerted and work is done in pulling them apart, we have the equivalent of that work in the form of an electric field capable of doing work. The motion of the pith-ball, and the heating caused by the tiny sparks which charge it, are evidences of the truth of the statement. It is again worthy of note that both balloons appear exactly alike, and yet they assume opposite electricities. That there must be some difference may be readily seen from what follows. In most cases of friction, the nature of the rubbing and rubbed surfaces determines the kind of electricity which each assumes. Thus, if glass be rubbed by a cat's fur instead of silk, its electricity is — instead of +. In the following list, each body, when rubbed by any one preceding it, is negatively electrified; by any one succeeding it, positively: cat's fur, smooth glass, linen, feathers, wood, paper, silk, shellac, ground glass. When two pieces of the same material are rubbed together, the colder or smoother becomes positively excited. Metal filings rubbing against a plate of the same metal determine — electricity in themselves, and + electricity in the plate. When a white silk ribbon is rubbed by a black one of the same texture, the white one becomes +. A plate of glass becomes + when a stream of air is directed against it from a pair of bellows. The friction caused by steam of high tension issuing from a narrow pipe develops electricities in the steam and pipe which depend on the material of the latter. This fact has been turned to advantage by Armstrong in the construction of a boiler electrical machine of immense power.

Free electricity has the power of inducing the bodies in its neighborhood to assume a peculiar electrical condition; this is exhibited in the following simple way: A brass cylinder, rounded at both ends, is insulated on a glass pillar. Two pith-balls, hung by cotton threads, are attached at either extremity. When a glass tube is briskly rubbed, and placed within a few inches of the end of the cylinder, the balls at each end diverge, showing that each pair is charged with similar electricities. When the glass tube is withdrawn, the balls hang down as before, so that the electrical excitement of the cylinder is merely temporary, and dependent on the proximity of the excited tube. If, while the balls are apart, a *proof plane*, consisting of a small disk of gilt paper insulated at the end of a glass rod, be made to touch the end next the tube, and then transferred to an electrometer, the electricity is found to be —; if the same be done at the other end, it is +. The nearer end of the cylinder is thus induced by the + electricity of the glass to assume the negative electric state; and as no — electricity can be excited without as much + electricity, we find the other end positively electrified to the same extent. It appears, besides, from the positions taken up by them, that *both electricities observe the same attractions and repulsions as the bodies affected by them*. This action of the electricity of the tube inducing in the cylinder this peculiar electrical condition is called induction; and the cylinder in this state is said to be *polarized*—that is, to have its poles or ends like a magnet, each having its similar, but relatively opposite, force. If the hand touch the cylinder, the balls next the tube diverge further than before, and the other two cease to be affected. In this case, electrically speaking, the cylinder is a portion of the ground, for the hand and body are conductors; the ground is thus brought nearer, more — electricity appears, and the + electricity is lost in the spark with the hand. The — electricity is kept fixed in the part of the cylinder opposite the tube by the + electricity of the latter; and when the hand is first removed, and then the tube, it causes the balls at both ends to diverge permanently. We thus see that electricity can be produced and insulated in conductors by the action of free electricity on them. The + electricity of the further half of the cylinder is as free and insulated as if no — electricity existed within it. This is shown by placing a cylinder near the first, forming a continuation of it, as it were, without touching, when the second cylinder, under the induction of the + electricity of the first, is thrown into the same state as the first. This second can induce the same state in a third, and so on. As the excited tube is withdrawn, the whole series return to their natural condition without being in any way permanently affected. The moment, however, it is again brought near, there is manifested at the further termination of the last a + electricity, which exerts the same influence there as if a portion of the electricity of the tube had been actually communicated or transferred to it. The air intervening between the tube and the cylinder is termed the *dielectric*, for it is through it that the electric action is propagated. In proof of this, we have only to place a cake of shellac between the tube and cylinder, when the polarity of the cylinder will rise higher than before, as would be shown by the further divergence of the balls; and if this or a similar experiment be conducted with sufficient care, we find that the inductive action varies in amount for each non-conductor. Induction, therefore, we have reason to conclude, is not the direct action of one body on another, but an action transmitted through, or possibly residing in, the medium between them. In further proof of this, Faraday, who was the first to examine the function of the dielectric in induction, has shown that the action takes place through air in curved as well as in straight lines, which implies the action of an intervening medium. The relative powers of different substances in facilitating induction are termed by this philosopher *their specific inductive capacities*. The following table by Sir W. S. Harris gives the specific inductive capacities of the more important non-conducting substances, taking that of air as unity: Air, 1.00; resin, 1.77; pitch, 1.80; beeswax, 1.86; glass, 1.90; sulphur, 1.93; shellac, 1.95; India-rubber, 2.8. All gases, whether simple or compound, have the same inductive capacity, and this is not affected by temperature or density. If a large plate of metal be placed between the glass tube and the cylinder, the polarization of the cylinder instantly vanishes, for the induction is diverted by it into the ground.

Some idea of the meaning of the word *potential* may be got from the following comparison. Suppose we have a supply of water with a certain head, to fill an elastic bag: when the water is admitted, the bag will swell till the elasticity of the bag is equal to the head of water, and then the flow will cease. The potential is the head of water or elasticity of the bag, so many feet high, or so many pounds per square inch. The capacity of the bag is usually the amount it holds, but capacity in an elastic bag is a shifting quantity, and we must use the term in this way if we wish to compare the capacity of two elastic bags—

viz., the ratio of the water it holds to the head that filled it. Thus, a bag holding 10 gallons with a head 1 foot would have a ten times greater capacity than a bag holding 10 gallons with a head 10 feet; for if the first were pressed by a head of 10 feet, it would hold 100 gallons, the resistance of the bag being supposed to increase with its contents. Now, let us take a somewhat similar electric problem. An insulated ball is connected with a magazine of energy, ready to make electricity flow when occasion offers, such as a galvanic battery. Let the + pole of a gigantic battery be connected with the ball, and the other pole with the ground: electricity will flow to the ball till the air between the ball and the ground presents an electric reaction equal to the potential of the battery. The charge of the ball taken with reference to this potential gives the capacity of the ball. So much, then, for a popular view of these two words. The potential of a body, or any point in the field, is defined thus, viz.: *the amount of work that would be expended in bringing a small quantity, a unit of + electricity, from an infinite distance to the body or point.* If the body is positive, the work would be expended; if negative, the work would be done on the body and the potential –. The said unit of + electricity will always move from a point where the potential is high to one where it is lower; in other words, electricity will always flow between two points where there is a difference of potential, and will cease to flow when that difference ceases. If E be the charge, V the potential, C the capacity, then $C = E \div V$. From the definition of potential just given, what we have called the potential of the battery in the preceding illustration is in reality its *electro-motive force*, or the difference of potentials of its poles. As these are alike in power but different in sign, and as the difference of two quantities of unlike sign is their sum, the electro-motive force is twice the potential of one pole. If the charging-line be withdrawn, the ball will be in all respects as if charged by an electric machine. The battery having, so long as it acts, an unlimited supply of electricity, its electro-motive force remains the same; but when balls charge one another, the potential falls just as when a limited supply of water has its head reduced when made to run into another vessel. Potential, then, must be estimated by the resistance of the field, or the work value of the unit of charge. The charge being the same, the potential rises with the smallness of the body or the thickness of the dielectric. Density is the quantity of electricity on a unit of surface, and *tension* is the strain which Faraday supposes to exist in the molecules of a dielectric when charged. Tension is commonly used in this country and abroad for potential, though our best writers never use it now in this sense.

We might take it almost as a self-evident truth, that the greater the surface over which electricity is diffused, the less is its electric potential at any particular point, and so we are taught by experiment. When two equal balls are insulated, and a charge is given to one of them, and then communicated to the other by contact with the first, it is found that both equally divide the charge, but that the potential of the electricity of each is one half of that of the originally charged ball. When a watch guard-chain is charged and laid on the plate of an electroscope by means of a glass rod, the gold leaves diverge most when the chain lies in a heap on the plate; and as it is lifted up, the leaves approach each other, showing that as the exposed surface of the chain increases, the electric potential of each part diminishes. The reason of this is obvious. Let us begin with one ball with a certain charge, then take another equal ball and impart half the charge to it by making the two touch. A spark will be seen at the charge of the second ball. The quantity in both is still the same, but energy has been lost by the spark, and the heat generated by the spark is the measure of the loss. If we continue to add ball after ball until we have a very large surface, the quantity is the same as at first, but energy has been squandered in the sparks of each additional ball, and so the potential is lowered. Experiment teaches us that electricity is exhibited only on the surfaces of conductors. A brass ball is suspended by a silk thread, and covered with two hemispheres, which can be held by insulating handles, and which exactly fit it. A charge is then communicated to the ball so compounded. When the hemispheres are withdrawn, they are found to take away all the electricity with them, not the slightest charge being left in the ball. The same fact is exhibited by a hollow ball placed on a glass pillar, with a hole in the top large enough to admit a proof-plane to the inside. When charged, not the faintest evidence of electricity is found on the inner surface, however thin the material of the ball may be. The thinnest metal plate, when under induction, shows opposite electricities on its two faces. We learn from these and numerous other experiments that *electricity is only found on the outer surfaces of conductors in an envelope of inappreciable thickness.* This fact is quite in keeping with Faraday's theory of the action of dielectrics. Within a conducting body we cannot expect electricity, for the moment it appears in it the particles communicate their electricities to each other, and the electric state ceases. In a dielectric they cannot communicate, and the charge remains. Hence the charge at the conductor only appears at the junction of a conductor and dielectric. We are also taught by experiment that the distribution of electricity on the surface of insulated conductors is influenced materially by their form. An electrified ball, for example, exhibits the same density all round, for the resistance is sensibly the same on all sides of it. When, however, a conducting body is made to approach near enough to it, the density of the electricity is found to be greater on the side on which the approach is made. This is proved by the aid of a proof-plane and an electrometer. When work is done in drawing away the proof-planes from the charged body, its potential, as tested by the electrometer, is proportional to the density of the charge at the point where it touched. The reason of this unequal distribution is obvious from the fact that the potential of the ball must be the same at every point. If, therefore, the resistance at one side be less than at another, the density there must be greater to maintain equality of potential. The disturbance of equal distribution here spoken of holds true only for short distances; the disturbing body, for instance, in the case under consideration, has to be brought very near before any inequality in the distribution of electricity on the ball becomes manifest. It is to this concentration of electricity on the side of the approaching conductor that we owe the electric spark; and it is as we near the striking or sparking distance that this disturbance is revealed. The concentration or fixing of electricity on the side of the thinnest and best dielectric is particularly illustrated in the condenser and Leyden jar, whose action depends upon it; but in these the dielectric must be very thin to secure decided effect. When a conductor somewhat in the form of a prolate spheroid is charged, and the electric density of the several parts tested by the proof-plane, it is found to be least at the thickest part, and to increase towards either end; and the difference is found to be all the greater as each end becomes more and more pointed. It is found likewise that the electric density on a point is so great with a considerable charge as to destroy the dielectric condition of the air, the particles of which become electrified, and carry by convection the charge of the point to surrounding conductors. We therefore learn that *electricity concentrates on points and projections.* A similar reasoning with regard to the relations of potential resistance and consequent density bears here as in the previous case. It may be here remarked that the density of charge at any point regulates the amount of tension at that point on the molecules of the dielectric. The constraint which they experience in being charged, and which Faraday calls tension, can only be carried to a certain limit. When that is reached, the molecules are forced to be conducting, and the tension ceases.

The words electrometers and electroscopes are generally taken as synonymous; electroscopes, however, should be applied to the instruments which give evidence of electrical potential without giving the exact measure of it; and electrometers to such as show both. Of late years immense progress has been made in the construction of delicate electrometers, chiefly to meet the demands for such in the working or testing of submarine cables. Sir William Thomson's quadrant electrometer and his absolute electrometer in point of exactness and delicacy are a hundred-fold in advance of previous instruments. The *gold-leaf electroscope* is a handy instrument for estimating roughly medium potentials. In one of the best of its forms a glass ball, about 4 inches in diameter, rests on a brass tripod, and its neck, about 1 inch in diameter, is inclosed by a brass collar fixed with shellac. A brass plate, with a hole of ¼ of an inch in diameter in the middle of it, can be screwed airtight into the collar. Before it is so fitted, a brass rod, ⅛ of an inch in diameter, is fixed by shellac or sealing-wax into the hole in the middle, so as to be perfectly insulated from it. The upper end of the rod terminates in a brass ball, and the lower end is filled on each side, to allow of two strips of gold-leaf, 1 inch long, being attached to it. Before the plate and leaves are finally fixed, the interior of the ball is thoroughly dried by passing hot dry air into it, so that the ball contains no moisture to carry away the charge of the leaves. When the plate is screwed to the collar, there is no communication between the included and external air. The insulation of the leaves is complete; and they keep their charge in dry weather for hours together. When the instrument is used, it may be charged directly, by contact being established with the ball and the body whose electricity we would examine, or a charge may be carried to it by the proof-plane, when the leaves diverge according to the charge communicated.

Coulomb's Torsion-balance has played an important part in examining the laws of electric forces. A glass canister (Fig. 1) is placed on a wooden frame, and is covered above by a plate of glass or wood; in the middle of this plate a round hole is cut, over which is fixed, by wooden fittings, a long glass tube having the graduated rim of a circle attached at its upper end. A circular plate, resting on this rim, closes the upper end of the tube; and when it is turned round, a mark upon it tells the number of degrees through which it has been moved. A cocoon thread or very fine wire is tied to a hook in the center of the lower side of this plate, and thence descends to the body of the canister. It carries below a collar of paper or other light material, in which a needle of shellac is adjusted having a disk of gilt paper placed vertically, or a gilt pith-ball at its one end and a counterpoise at its other. When the plate above is moved through any number of degrees, the needle below, impelled by the torsion of the thread, comes to rest at the same number on the scale below. This last consists of a strip of paper divided into degrees, pasted round the cylinder at the same height as the needle. In the cover of the canister there is another opening, for the admision of a ball insulated at the end of a rod of shellac, and which, when supported by the cover, is on a level with the paper disk of the needle. When adjusted for observation, the mark on the upper plate and the paper disk stand each at the zero-points of their respective scales, there being of course no torsion in the thread. The ball is removed to receive a charge from the body under investigation, and is then placed in the cylinder, when the disk is first attracted, then repelled. Suppose that the disk be driven 40°, as shown by the lower scale, from the ball, and that the upper plate has to be moved in the opposite direction, through 160° of the upper scale, to bring it back to 10°; the total degree of torsion is 160 + 40° = 200°. If the ball and disk be now discharged, and another charge be given to the ball, which requires 250° of torsion to place the disk at 10°, we have the relation 200 to 250 as that of the repulsive forces of the two charges, for the amount of torsion in degrees is proportional to the twisting force. Without entering further into detail, we may state the two laws that Coulomb established by this instrument: *The intensities of the mutual repulsion or attraction of two invariable quantities of electricity of the same or different names are in the inverse ratio of the squares of the distances at which these act. The intensities of the total repulsive or attractive action of two electrified bodies placed at an invariable distance are proportional to the products of their electric charges.*

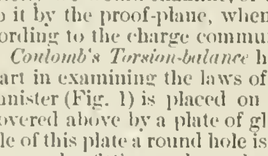


Fig. 1.

In the tube of glass and silk rubber of which we have made frequent mention we have the embryo of the electric machine, viz., a body which when rubbed is positively electrified, and its rubber negatively. The first requisite we should expect in a *machine* of this nature is a large surface, to give a great amount of electricity. But there is another already casually referred to: glass being a non-conductor, the electricity formed on its surface has not a combined action, so that some arrangement is necessary to collect it and render it available—to act, in fact, as its conducting reservoir. This portion of the machine is denominated the *prime conductor*. The rubbed surface of the electric machines is either a cylinder or plate of glass; hence we distinguish them into cylinder-machines and plate machines. The former, from their more compact form, are the more manageable; and the latter, from both sides of the glass plate being rubbed, are the more powerful forms of the instrument. In frictional machines there are two ways in which energy is expended—in friction, and in drawing away the two excited and attracting surfaces. Much of the force expended in friction results in heat, and only a fraction (sometimes a small one) in electricity. Of that spent in drawing away, which is the less considerable, the whole results in increased potential. Machines are therefore very desirable where, with a small initial charge, a constant supply of electricity may be got by the latter method. The electrophorus is a machine of this kind, and has been known since 1776, and Nicholson's doubler, another, since 1788. But the action of these has only been on a small scale. Lately, however, induction-machines of great power have been made, the powers of which quite eclipse the older frictional machines. The best known of these is Holtz's machine (invented 1865), which will suffice to show the general construction of such. Fig. 2 shows Queen's Toepler-Holtz electrical machine, which is destined to be the machine of the future. Omitting a description of the machine, the details of which are clearly set forth in the drawing, we will notice the manner of its operation. Suppose we wish to work the machine, whose plate is two feet in diameter, the usual size. We first put the two poles in contact and see that the revolving plate passes an opening before coming to the row of teeth. We next take a sheet of vulcanite about the breadth of an armature, and rub it with cat's skin (making it −), hold it close to the armature, and then make the plate revolve. We at once know if the machine is working by a rushing sound. We now gradually withdraw the two balls at the poles, and a rush of straight, bright, but not very dense sparks leap across between the two for the first 2 inches or so. When the distance becomes greater than that, brushes proceed from each end, and there is a fine purple glow in the central space. If we withdraw the poles to 5 or 6 inches, two well-defined brushes are seen, one at each pole. If now the hand be placed on one pole and the other hand presented to the other, sparks of 2 inches are got which produce a most painful stinging sensation on the hand, but cause no twitching at the joints of the arm. When the poles are at a distance of half an inch, paper and other combustible substances may be kindled by the spark. On examination it is found that the armature first touched by the excited vulcanite is —, and that the other is +. The plate is + below; that is, after passing the negative armature; and — above, after passing the + armature. If the motion of the plate be reversed, the electricity of the poles changes sign or ceases altogether, when the machine must be excited anew. If kept moving in the same direction, and allowed to rest only for short intervals, it may be kept in action for hours together without renewed excitement. In order to get long dense sparks, a small Leyden jar is hung on the rods with their outer coatings in metallic contact. With these condensers a splendid series of long, intensely brilliant sparks of six inches in length are got, each accompanied with a snap painfully loud, quite eclipsing anything shown by friction-machines. The condensed spark does not kindle paper, but gives a very powerful shock. We have not space to enter into the theory of Holtz's machine. Indeed it may be questioned if, in all points, its action has been fully accounted for. We would only say that reciprocal action of the armatures on each other is common to all induction-machines, and is quite similar to Siemens and Wheatstone's principle for magneto-electricity.

By discharging the Leyden jar or electric battery through particular channels, we obtain some beautiful illustrations of the power of electricity. When the discharge is effected through thin wires of gold or platinum, the heat accompanying its passage is so great as to dissipate them in vapor. The expansion of the air caused by the spark is shown by the *electric mortar*. This is a wooden mortar with two wires entering air-tight at the opposite sides of the breach, with a small wooden ball fitting closely in the muzzle. The spark passing between these wires in discharge causes a sufficient expansion of the air within the mortar to drive the ball to some distance off. When the discharge is made through gunpowder, it tosses the grains violently about, but causes no ignition; when, however, it is retarded by introducing an imperfect conductor, such as a wet string, into the circuit, the gunpowder is fired. When the discharge is made through glass by two points pressing against its opposite surfaces, a small hole is drilled into the glass.

The velocity of electricity is found to vary with the nature of the circuit to the extent, indeed, of its inductive embarrassment. Thus, in air-lines of telegraph it is greater than in sea-cables. Wheatstone was the first to determine the velocity of electricity in an insulated copper wire stretched in air. He did this by the device of a revolving mirror. Any one who takes a mirror in his hand and makes it revolve sees that objects are apparently displaced by it, and that the reflected image describes an angle the double of that of the mirror. If, while the small mirror rotates at 50 turns a second, the image of a spark should show a displacement of 90°, we know that the mirror has moved through 45°, and the time during which this takes place is $\frac{45}{360}$ of $\frac{1}{50} = \frac{1}{400}$ of a second. If the duration of the spark, then, had been $\frac{1}{400}$ of a second, we should have seen its image move through 90°. The eye, however, during this time would not have been able to discern any difference between the beginning and the end of the spark, so that the 90° would have appeared as one arc of light. Examined in this way, however, the spark of a machine and of a Leyden jar were seen as if the mirror had been at rest. He arranged a Leyden-jar circuit of half a mile with three breaks in it, two near the coatings and one in the middle of the half-mile, and had these breaks placed nearly side by side, so that the sparks at them, when discharge took place, could be seen together in the revolving mirror. He found that all three sparks had a duration of $\frac{1}{24000}$ of a second, and that the middle spark occurred so far behind the other two as to indicate a velocity of 194,000 miles per second in the wire.

There are two theories which have played an important part in the history of the science—the two-fluid theory of Dufay, and the one-fluid theory of Franklin. According to the former, matter is pervaded with two highly elastic imponderable electric fluids—one, the vitreous; the other, the resinous. These are supposed to repel themselves but attract each other. Neutral bodies give no evidence of their presence, for they are there neutralized the one by the other; but when by friction or other operation

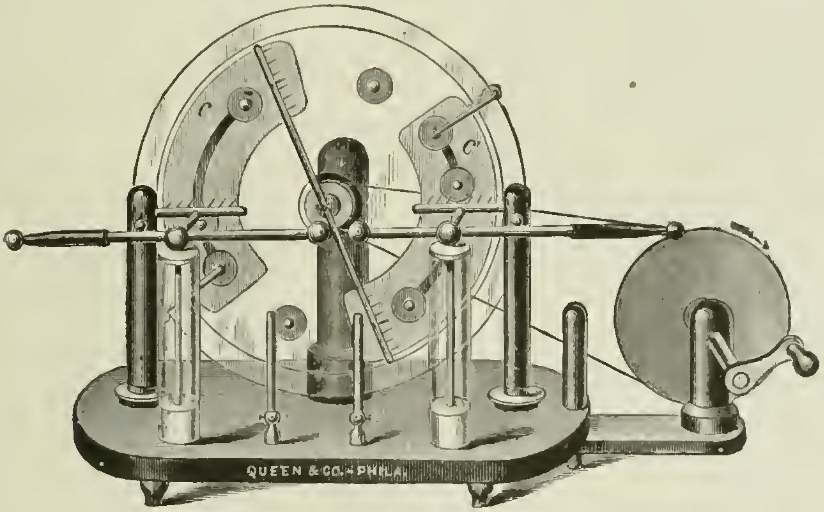
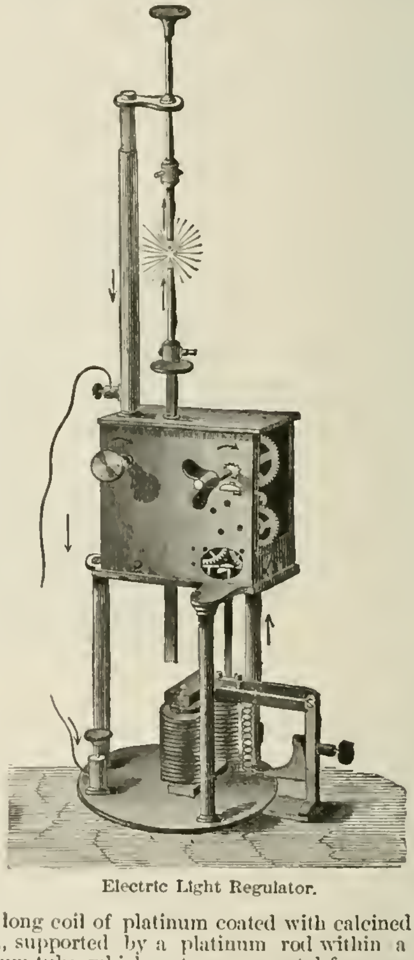


FIG. 2.

the fluids are separated, each body observes the attractions and repulsions of the fluid it happens to have. According to the latter, there is only one electric fluid which repels itself but attracts matter. Friction determines a gain of the fluid to the positive, and a loss to the negative, body. Faraday's theory of electric induction by contiguous molecules appears to be gaining ground. It explains satisfactorily how conductors and non-conductors are alike in kind; how the charge on the conductor can only reside at the boundary of the conductor and non-conductor, or—which is the same thing—the surface of the conductor; how the charge resides *in* the dielectric; how the polarity of the galvanic circuit is effected; how a battery-current originates in and effects chemical decomposition; and how the velocity of discharge is dependent on the conformation of the circuit. Prof. Clerk Maxwell's classical work, *Electricity and Magnetism* (1873) gives to Faraday's views a mathematical significance and comprehensiveness hardly contemplated by the great philosopher himself. See *Galvanism* and *Magnetism*.

ELECTRIC LAMPS.—The more recent inventions of electrodes producing light are those of Jablochkoff, Lodyguine, Kohn, Sawyer, and Edison. The first of these produces the light by the electric arc; the others by the incandescence of some refractory substance, as carbon or platinum. The principal difference between the Jablochkoff light and the ordinary arrangement with carbon points is in a provision by which the current is reversed from time to time so that the more rapid consumption of the positive electrode is made to take place with one and the other point alternately. When the apparatus is started, there is also a slight bridge of carbon between the two points through which the current passes before the arc is established. The carbon rods are placed parallel and near together, so that a uniform distance may be maintained during their consumption. A pair of carbon points constitutes a "candle," and four candles are usually placed in a globe of opalescent glass. Each candle burns about one hour and a half, so that the set of four will give light about six hours, the change of electric action from one candle to another being accomplished by an automatic switch. The motive power required in the Jablochkoff lamp is about one horse-power applied to a magneto-electric machine for each candle, and each such candle is said to have a light-value of 700 standard candles; but this, from the absorption of light by the opalescent glass, is reduced to that of 300 candles. In 1873, M. Lodyguine, a Russian as well as Jablochkoff, invented a lamp which gave light by rendering carbon incandescent by the electric current. A portion of the conducting-rod of carbon was made much thinner than the rest, so that the increased electrical resistance in that part would cause it to become intensely incandescent. The carbon rod was inclosed in a glass vacuum-chamber, but the apparatus was not practically successful, as the carbon wasted too rapidly, and required too frequent replacement within the vacuum-chamber. In 1875 M. Kohn of St. Petersburg patented an arrangement intended to obviate this difficulty by a device having the same object as that in the Jablochkoff lamp, viz., to supply the place of the consumed carbon with a new piece. This lamp has been used with considerable success. The Sawyer lamp has the following characteristics: It employs the resistance of a small piece of carbon, placed in an air-tight glass cylinder filled with pure nitrogen, which, being a non-supporter of combustion, protects the carbon in a manner like that of a vacuum, the advantage claimed being that it is easier to keep a vessel full of pure nitrogen than to maintain a vacuum, because of the equality of the inward and outward pressure. The heat produced is prevented from reaching the mechanism at the base of the apparatus by having the copper standards present a great radiating surface. Diaphragms are also placed so as to cut off much of the downward heat-rays, and a switch device is employed to prevent the too sudden turning on of the current, and thereby prevent crumbling by too sudden heating. The experiments of Mr. Edison on the electric light have been in progress several years, in which time he has used various substances for the incandescent material. He commenced with platinum, and employed a device by which the galvanic current would be reduced when the metal approached the melting-point. This device consisted chiefly in placing within the fine platinum spiral a rod of the same metal which would be moved, on the principle of the pyrometer, one way or the other by a lever, and thus cool by its presence the incandescent spiral when it became too hot. But this device did not prove successful. Another arrangement employed heated air acting upon a diaphragm as the regulating power. The various metals which he used soon became oxidized and rendered useless. He then gave his attention to perfecting the vacuum employed by Lodyguine in 1873. Edison's platinum lamp as perfected consists



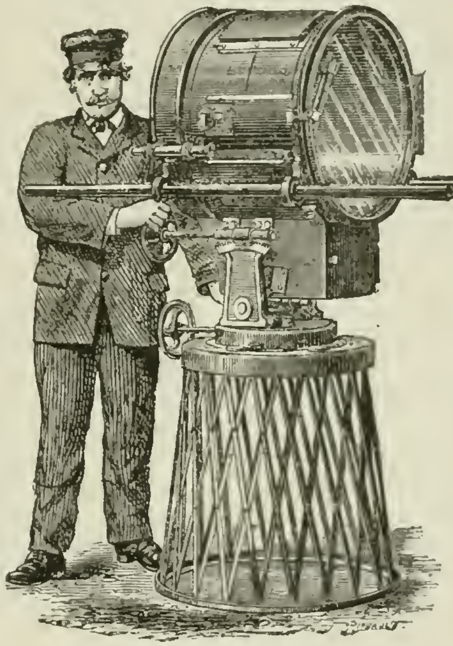
Electric Light Regulator.

of a long coil of platinum coated with calcined magnesia, supported by a platinum rod within a glass vacuum-tube, which rests upon a metal frame containing the regulating apparatus. It is claimed that Edison has produced a vacuum more perfect than any other, so that only one millionth of an atmosphere remains. His attention was called from the use of platinum to that of small threads of carbon, made by charring cotton thread in a vacuum with the electric current. Light of great intensity was obtained in this way. He experimented with various forms of woody fiber, but finally found that nothing gave more satisfactory results than charred paper. Bristol card-board is cut in the shape of a horseshoe, the strips being about two inches long, and an eighth of an inch wide, and laid upon one another in an iron mold, being separated by tissue-paper. When the mold is packed, it is placed in an oven and gradually heated to 600°; afterwards in a furnace to a white heat. The carbonized product is then carefully removed and placed in a small glass globe, and made the resisting portion of the galvanic circuit; the globe is then exhausted and sealed air-tight. The drawing represents the most approved electric-light regulator, with double clockwork, after Foucault's arrangement. See *Electric Light*.

ELECTRIC LIGHT.—Powerful electric lights have become exceedingly important as engines of war, and the soldier and sailor vie with each other in the development of apparatus suited to their special needs. Enormous increase in the power of single lights has been obtained during the past few years by the great improvements which have attended the introduction of electricity as an illuminating agent. This has benefited the defense more than the attack, whether the operations be on land or sea; for, usually, the main functions of a powerful light are to guard against surprise, to give the defenders a timely warning, and thus enable them to aim at the advancing forces. The defense can, moreover, employ the most powerful lights, the machinery for which is ponderous and not suited to the mobility required by the attack. Nevertheless the use of a powerful light may frequently aid the attacking forces very materially. Thus at the attack on Charleston, during the War of Secession, the Southerners were prevented from repairing the breach in Fort Sumter by night on account of a deadly shrapnel fire which was directed upon the breach by the aid of a lime-light, which is so inferior to the light now obtainable by means of the electric arc. Again, in an advance over obstacles, it has been found that the attacking party will often receive great assistance even from the electric lights of the defense. As before stated, however, the balance of advantage appears to be considerably on the side of the defenders. In all descriptions of siege-operations the employment of the electric light has become a matter of considerable importance, many operations which it has hitherto been customary to perform under the cover of darkness being no longer possible, and other operations, such as the bridging of rivers, which formerly could only be carried on during daylight, being now possible on the darkest night.

The two important war-services for which powerful electric lights have been provided, in England, are: 1. As search-lights for the vessels of the Royal Navy. 2. As search-lights to act in unison with the artillery and submarine mining defenses of ports and harbors. In the one case the machinery is carried on board the large men-of-war, and in the other case is erected inside the forts. In each of these positions the machinery can be placed practically out of reach of an enemy's shot and shell; but the protection of the projector, and of the men who manipulate it, can never be so satisfactorily provided for, and the subject has consequently received a good deal of attention, both in the army and navy. The subject has especially been worked at by the Royal Engineers, and has been attacked in two ways: 1. By attempts to place the projector and manipulator out of the direct fire of an enemy, and to use a mirror for the final projection of the ray of light in his direction, such mirror being exposed to the fire, but being arranged so that it can be easily and quickly replaced. 2. By attempts to greatly decrease the cost of the projector, and to arrange the optical portions so that they can be expeditiously replaced if broken. The projectors at first used were large metallic reflectors, either spherical or parabolic; but a lighter, smaller, and equally powerful arrangement was found in the Fresnel lens, now called a spherical holophote. It consists of a central lens, generally in three elements, with a focal distance of .15 meter, and which receives dioptrically the light-rays in a cone of about 60 degrees. The catadioptric portion is composed of five or six annular rings so placed that the principal focus of each ring coincides with that of the dioptric portion. There is also sometimes added a small spherical metallic mirror, placed behind the focus, so as to catch and throw forward again the rays from the back of the arc-light. Owing to the short focal distance, it is very difficult to focus the light properly in these costly projectors, and the glass rings are frequently cracked by the flame and radiation from the electric arc. For short ranges, however, they are efficient.

These projectors have given place to a most effective arrangement designed by Colonel Mangin, of the Corps du Génie (French army), and which consists of a reflecting lens ground on the inner side to a spherical surface of somewhat shorter radius than the outer spherical surface, the glass of the reflector being, therefore, thicker at the sides than at the center. In fact, the projector is a spherical catoptric apparatus, the divergence of which is rectified dioptrically. The drawing represents a smaller Mangin projector,



Mangin Projector.

.60 meter in diameter, which differs in a few of the mechanical details from the larger sizes. It is fitted with two bars, and can thus be moved about by two men, the lattice-work stand being moved separately. All these projectors are costly, and to place them so as to look over the parapets of our forts or the bulwarks of our ships is to invite their speedy destruction by an enemy's fire. To meet this difficulty arrangements were made and tried at Chatham in accordance with suggestions made by Major Sale, R. E., C.M.G., in 1876–7, then Secretary R. E. Committee, to place the projector in a splinter-proof pit, and direct the beam of light on to a plane mirror placed a short distance off, and alone exposed to the enemy's fire. The results were encouraging, but difficulties were encountered in the fixing and manipulation of the mirrors, the apparatus tried being so weak that the wind moved the mirror unduly. In these designs the projector and the mirror or mirrors were placed nearly in the same horizontal plane, and there was a loss of light when the mirror was approaching at extreme angles of training. Moreover, the range was limited, and unless two mirrors were used (in some situations not convenient, and in others not possible) on opposite sides of the light, the portion of the whole circle illuminated was limited. And in some situations the length of parapet required could not be spared.

In April, 1880, Captain Bucknill, R. E., proposed the following arrangement: 1. To work the ray of light to the zenith, either directly or by means of a mirror. 2. To deflect this ray by an upper mirror carried in a framework or funnel. 3. To carry the funnel or tube that supports the upper mirror upon a ring, and this again upon rollers and another ring clamped or fixed to the inner wall or walls of a fort. A slow-motion screw, a worm, etc., would then move the funnel in azimuth at pleasure, and consequently the ray of light from the mirror. 4. To move the upper mirror by a slow-motion screw actuated by a light grip-wheel on the axle of such screw, which wheel can be turned by an endless cord from below, by a man who would take his orders through a speaking-tube from an observer in the firing station. The only commands required would be "Up," "Down," "Right," "Left," "Fast," "Slow," "Stop." Such a tube could be taken down at daybreak and put up again in the evening in a few seconds by an arrangement like that used in raising and lowering Thames steamboat funnels. It is difficult to work a light-ray direct to the zenith, especially with a Mangin projector, as the burnt pieces of hot carbon fall on the glass of the projector at the thinnest part (the center) and perhaps crack it. The vertical ray can, however, be readily obtained by means of a lower mirror. It should be noted that this arrangement provides for reflection at about 45 degrees, a very small angular movement of the upper plane mirror producing a large vertical motion of the ray of light. See *Dynamo-electric Machine* and *Electric Lamps*.

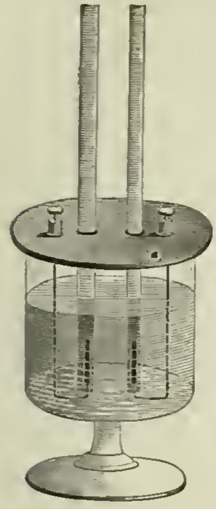
ELECTRIC PRIMER.—This primer consists of the long tube of the service friction-primer, split at one end to receive a large piece of brass tube, to which it is soldered. The larger tube incloses a cylindrical piece of hard wood, slotted midway of its length, and perforated at each end to receive short pieces of copper wire, which are connected across the slot by a coiled piece of fine platinum wire. The outer ends of the copper wires project a few inches to connect the wires of the primer with the terminal wires of the battery. When thus connected, the battery-current, by reason of the resistance met with in passing through the platinum wire, heats this wire sufficiently to ignite a small piece of loose gun-cotton which, together with the platinum wire, occupies the slotted portion of the wooden cylinder. The ignited gun-cotton commmunicates its flame to the powder in the long tube. The open ends of the large tube are turned down on the wooden plug to prevent blowing out. These and the open ends of the small tube are closed and dipped in varnish, as described for the friction-primers. The platinum wire is coiled to increase its length between the copper ends. By this means the absorption of heat by the latter is overcome. The coil is also less liable to be broken by any slight displacement of the copper wires. With the standard length of one inch and thickness .003 inch for the platinum wire, the resistance of this primer is about 7 ohm cold and 1.2 ohm at explosion. Fulminate of mercury may be used instead of gun-cotton. The latter is preferred, however, as being equally serviceable and less dangerous. See *Friction-primers*.

ELECTRO-BALLISTIC MACHINES.—The accurate determination of the *velocity* of a projectile at any point of its trajectory has been one of the most difficult problems in the science of gunnery. It has exercised the talents and ingenuity of the best scientific minds of the age, and has given rise to much interesting discussion and many valuable experiments. The wondrous mechanical skill of the day, and our mastery over the powers of electricity, have, however, recently given us instruments which, in their results, more than realize the brightest dreams of the experimenters of a century ago. Their bulky, unwieldy, and expensive machines have given place to the neat and compact chronoscope, which, with its pencil of electric light, now notes with unerring certainty infinitesimal intervals of time. Besides the electro-ballistic machines, a great variety of instruments have been invented to determine directly the initial velocity of a projectile, the most reliable of which are the *gun-pendulum* and the *ballistic pendulum*. In the first the velocity of the projectile is determined by suspending the piece as a pendulum, and measuring the recoil impressed on it by the discharge; the expression for the velocity is deduced from the fact that the quantity of motion communicated to the pendulum is equal to that communicated to the projectile, charge of powder, and the air. The second apparatus is a pendulum the bob of which is made strong and heavy, to receive the impact of the projectile; and the expression for the velocity of the projectile is deduced from the fact that the quantity of motion of the projectile before impact is equal to that of the pendulum and projectile after impact. These machines have been carried to great perfection both in this country and France, and very accurate and important results have been obtained by them; but they are very expensive and cannot be easily adapted to the various wants of the service.

The employment of electricity to determine the velocity of projectiles was first suggested by Wheatstone in 1840. The application depends on the very great velocity of electricity, which for minute distances may be considered instantaneous. The general method of applying this agent is by means of galvanic currents, or wires, supported on target-frames placed in the path of the projectile, and communicating with a delicate time-keeper. The successive ruptures of the wires mark on the time-keeper the instant that the projectile passes each wire, and knowing the distance of the wires apart, the mean velocities, or velocities at the middle points, can be obtained by the relation, $\text{velocity} = \frac{\text{space}}{\text{time}}$. The various plans in use differ only in the manner of recording and keeping the time of flight; one of the simplest and most common instruments employed is the pendulum. The ballistic machine of Captain Navéz, of the Belgian service, has been tried in this country, but has been found too delicate and complicated for general purposes. See *Chronoscope* and *Electric Clepsydra*.

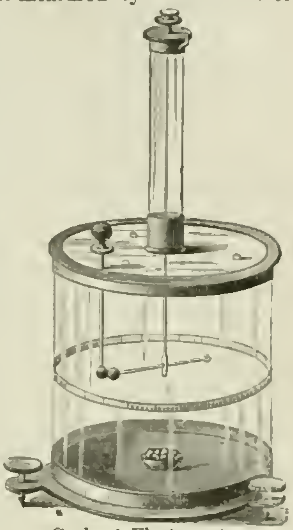
ELECTRO-CHRONOGRAPH.—An instrument used for recording time and occurrences in the instant and order of their time, as in noting transits in observatories. A paper marked for seconds is placed on the surface of a revolving drum, over which is a stylus operated by electro-magnetic action when the circuit is closed by the telegraph-key in the hand of the operator, who is also the observer at the transit instrument. A mark is thus made on the time-paper at the instant of the occurrence of the transit. See *Chronograph*.

ELECTROLYSIS.—That division of the science of galvanism which treats of the laws and conditions of electro-chemical decomposition. As this decomposition is generally attended by electro-chemical combination, it is sometimes difficult to distinguish electrolysis from the more general subject of *electro-chemistry*, which embraces all chemical changes resulting in or from the galvanic current. In one case, however, the application of the term is strictly correct—viz., where decompositions are effected by electrodes which are not attacked by the elements of the electrolyte (the substance decomposed) discharged at them. No substance is decomposed by the current so long as it is in a solid or gaseous state, and it must first be brought to a liquid state, either by solution or fusion, before the current acts on it. The decomposition of water by platinum plates is always taken as the type of electrolytic action. In a very convenient apparatus for the purpose, a glass basin is made so as to admit a cork below, through which two wires pass having slips of platinum plate soldered to them above. Two glass tubes, open below, are hung over the plates, to hooks projecting from an upright support. The bowl is filled with acidulated water; and the tubes, after being filled with the same, are inverted, and hung with their lower ends inclosing the plates. When the wires projecting downward from the cork are connected with the poles of the battery, hydrogen rises from the negative, and oxygen from the positive electrode, to fill each its separate tube. As the decomposition proceeds, twice as much hydrogen is liberated as oxygen. When the tubes are filled, they may be removed and examined. The oxygen thus obtained smells strongly of ozone. Hydrogen is here the type of the metals or other electro-positive substances (cations), which, during electrolysis, are always disengaged at the negative electrode; and oxygen of the salt radicals, chlorine, iodine, sulphur, etc., which, being electro-negative (anions), always appear at the positive pole. Moreover, the proportions of the volumes of the two gases being that of their chemical combining volumes, reminds us that, when a body is decomposed, its components are always separated in the proportions in which they were united, viz., those of their chemical equivalents. If the tubes of this apparatus were graduated, it would serve for a voltameter. If, instead of one such voltameter included in the circuit, we had several, we should find that, whatever amount of gas was liberated in one of these would be liberated in all, and that independent of the size of the plates and amount of acid in each. We learn, therefore, that the chemical power of the current is the same at every point of the circuit where it is manifested. From numerous experiments it has been concluded that electrolytes are resolved under the action of the current into anions and cations which appear at their respective electrodes in the proportion of their atomic weight, or multiples of their atomic weights. It is not only in cells exterior to the battery that this law holds, but in the cells of the battery itself. If the battery which effected the above decomposition consisted of six cells, for the equivalent atoms of hydrogen, tin, and lead separated without the battery, equivalent atoms of zinc in each cell would have been dissolved, and an equivalent disengagement of atoms of hydrogen at each of the copper plates, if the cells were one fluid. The above law holds not only for compounds whose elements enter into combination with their usual atomicity, but for those in which the elements, through the same, change their atomic equivalents. Thus, if the same current pass through two decomposing cells, one containing a solution of the cuprous chloride (CuCl), and the other of the cupric chloride ($CuCl_2$), the same quantity of chlorine will be disengaged in both, but twice as much copper is deposited in the first as in the second. Here the copper alone changes its atomicity, hence the change in the amount of it in the consecutive cells. The accuracy of the electrolytic law is somewhat compromised by the fact that liquids possess, to a certain extent, the power of conducting, physically, electricity without electrolytic action, so that all that passes in this way is chemically lost. Fortunately the error thus introduced is very small, and can be therefore practically disregarded. The drawing represents an improved water decomposing apparatus, consisting of a glass goblet, with binding-screws, platinum electrodes, and finely graduated bell-tubes for the gases. See *Galvanism.*



Decomposing Apparatus.

ELECTROMETER.—An instrument to measure the amount of electrical force. In Coulomb's torsion-electrometer, shown in the drawing, the force opposed to that of electricity is the resistance to twisting offered by an elastic thread. In Henly's quadrant-electrometer the electric force is measured by the amount of repulsion which it produces upon a pith-ball attached to a silk fiber suspended from the center of a graduated arc. Sir William Thomson's and Varley's electrometers are the most delicate of all, and are used in reading the insulating power of telegraph-cables. The quadrant-electrometer consists of a conducting-rod, generally of box-wood or brass, with a graduated semicircle attached above, in the center of which is a pivot for the rotation of a straw carrying a pith-ball at its outer end. It is used for a charge of high potential, such as that of the electric machine. When placed on the prime conductor of the machine, the whole becomes charged with + electricity, and the ball is repelled first by the electricity of the rod, and then by that of the prime conductor, the height to which it rises being seen on the semicircle. This is not an electrometer in the strict sense of the word, for although it tells us, by the straw rising and falling, when one potential is greater or less than another, it does not tell us by how much, the conditions of its repulsion being too complicated for simple mathematical expression. It can show us, however, by the indicator standing at the same point, when the electric potential of the machine is the same at one time as at another. The strength of the electric force excited by the rubbing of glass, sulphur, amber, wax, resin, etc., was measured by Gilbert by means of an iron needle moving freely on a point, *versorium electricum;* very similar to the apparatus employed by Haüy and Brewster in trying the electricity excited in different minerals by warmth and friction. See *Electricity.*



Coulomb Electrometer.

ELECTROPHONE.—An instrument devised by Dr. Strethill Wright for producing sound by electric currents of high tension. In its simplest form the electrophone consists of two metallic plates separated by a sheet of cartridge-paper, the whole being closely pressed together by a heavy weight or screw. Such an instrument, when its plates are connected with the terminals of a small induction-coil, forms a sonorous condenser, the note of which varies with the rapidity of action in the electrotome, or contact-breaker. The more complicated electrophone communicated to the Royal Scottish Society of Arts, 25th April, 1864, by Dr. Wright, is composed of four curved plates of the thinnest sheet-zinc, each 2 by 4 feet, and each separated from its neighbor by a double layer of imitation silvered paper, the silvered sides being in apposition to the zinc. The first and third, and second and fourth plates are connected by fine wires, which also connect the instrument with the induction-coil. When this instrument is connected with a small coil, the terminals of which afford a spark almost inaudible, it becomes charged and discharged with each impulse of current, each charge being attended by a sonorous tap given out by the whole mass of metal thrown into vibration, and the rapid succession of taps producing a prolonged trumpet-note, the power of which may be increased by adding battery-power to the coil. The electrophone has been recommended by its author for use as a telegraphic relay capable of giving two or four signs with a single wire, with the advantage over other relays that perfection of contact is not necessary to its working. Fig. 1 shows the mode of working the electrophone as a double relay with four signals and the galvanometer of Thomson; A represents the needle of the galvanometer, B and C the wires communicating with an electrophone. When the needle is deflected to the right, it falls on the points B and C, and sounds the electrophone through B, A, C. The signals are produced by long and short contacts, as in the code of Morse. The second set of signals are produced by the reversal of the line-current, which throws the needle on the points of the arrangement D connected with a second electrophone of different tone.

FIG. 1.

The electrophone has been employed as a lecture-table instrument to report to a large audience results of processes which can only be rendered sensible by the most delicate galvanometric apparatus. Fig. 2 shows the adaptation of the electrophone to the galvanometer. AB represents the needle of the galvanometer suspended by a silk fiber, C; D is a small vessel of mercury communicating by a fine wire with the center of the needle; while a similar wire, attached to the end of the needle B, dips into the curved trough EF, containing distilled water. The wires inserted into D and F connect the coil with the electrophone, the current passing through F, E, B, D. When the needle is deflected, the tract of water between E and F is shortened, and the electrophone gives forth a gradually increasing sound. By a delicate system of levers attached to the wrist, as in the sphygmograph,

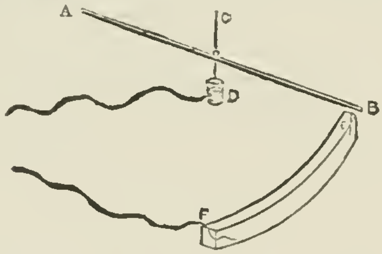


FIG. 2.

the rhythm and character of the human pulse, and its variation in disease, may be indicated to the class by the physician. Further, the electrophone may be adapted to the telephone by making the telephone-membrane act the part of a make-and-break for the current circulating in the primary wire of induction-coil. This can easily be done by leading the current through the membrane, and through a spring carrying a platinum point, which presses lightly against a piece of platinum attached to the center of the membrane. If the sounds uttered into the telephone be sufficiently strong to make the membrane so to vibrate as to cause actual separation between the platinum surfaces, they will be reproduced with great loudness in the electrophone; but if, as in the case of speaking, they be merely able to cause variations of pressure at the surfaces, they will be but imperfectly heard. Hence the electrophone succeeds best with singing, and a song gently sung in one place may be repeated in trumpet-tones in another hundreds of yards distant.

ELECTROSCOPE.—An instrument for detecting electrical excitation. In its usual form it consists of a glass jar with a wooden bottom, a brass wire passing through the cork and surmounted by a ball of the same metal; to the lower end of the wire are gummed two depending strips of gold leaf. The gold-leaf electroscope is a handy instrument for estimating roughly medium potentials. One of its best forms has a glass ball, about 4 inches in diameter, resting on a brass tripod, and its neck, about an inch in diameter, is inclosed by a brass collar fixed with shellac. A brass plate, with a hole ¼ inch in diameter in the middle of it, can be screwed air-tight into the collar. Before it is so fitted, a brass rod, ¼ inch in diameter, is fixed by shellac or sealing-wax into the hole in the middle, so as to be perfectly insulated from it. The upper end of the rod ends in a brass ball, and the lower end is filed on each side, to allow of two strips of gold-leaf, an inch in length, being attached to it. Before the plate and leaves are finally fixed, the interior of the ball is thoroughly dried, by passing hot dry air into it, so that the ball contains no moisture to carry away the charge of the leaves. When the plate is screwed to the collar, there is no communication between the included and external air. The insulation of the leaves is complete; and they keep their charge, in dry weather, for hours together. When the instrument is used, it may be charged directly, by contact being established with the ball and the body whose electricity we would examine, or a charge may be carried to it by the proof-plane, when the leaves diverge according to the charge communicated. When we would ascertain simply the kind of electricity with which a body is charged, we proceed in the following way: A glass tube is rubbed, and brought into the neighborhood of the brass knob; the leaves diverge by induction, and, when so diverged, the knob is touched with the finger, and the leaves fall to their original position, for they are then out of the line of action. In this state, — electricity is fixed by the action of the + electricity of the tube on the side of the knob next it, and the corresponding + electricity is lost in the ground. When the finger is removed, the + electricity is cut off, while the — electricity remains in the knob; and its presence is manifested by the leaves diverging permanently after the removal of the tube. If, now, a positively electrified body be brought near the knob, it draws away the — electricity from the leaves, and they consequently fall in; but if a negatively electrified body be brought near, it sends the — electricity more to the leaves, so that they diverge further. We are thus enabled to distinguish between a + and a — charge. See *Electrometer*.

ELEMENTS.—In a military sense, the first principles of tactics, fortification, and gunnery.

ELEPHANT.—The ancient Carthaginians and other nations employed elephants in war, not only as beasts of burden, but as combatants. These animals formed part of the army which Hannibal led across the Alps, and they are said to have decided the victory at the battle of Trebia. For a long time the elephant was as important an arm of war as the artillery of modern nations, and first became known in Europe from its employment in the wars of the East. They have been taught to cut and thrust with a kind of scimitar carried in the trunk, and it was formerly usual for them to be sent into battle, covered with armor, and bearing towers on their backs, which contained warriors. But the principal use of the elephant in war is for carrying baggage and for dragging guns. An elephant will apply his forehead to a cannon, and urge it through a bog through which it would be almost impossible for men and cattle to drag it; or he will wind his trunk round it and lift it up, whilst horses or cattle drag it forwards. They are extensively used, in India, for the draught of siege-trains, and in mountainous countries to carry mountain-guns on their backs. They are more sure-footed and serviceable than either horses or mules, in difficult mountain-roads. On the very steepest declivities an elephant works his way down pretty rapidly, even with a *howdah* and its occupants upon his back, his chest and belly on the ground, and each fore-foot employed in making a hole for itself, into which the hind-foot afterwards follows it, and to which the weight may be trusted, that another step may be ventured with safety. The load for steady work varies from 1700 to 2200 pounds, and the pace is from 3 to 3½ miles per hour. See *Pack-animals*.

ELEVATED BATTERIES.—Batteries in which the platforms of the guns are on the natural surface of the ground, or above it. These batteries are more simple in construction than any of the other kinds, because the arming of the batteries can be made independent of the execution of the parapet. Enfilading-batteries should have their crests as nearly as possible perpendicular to the prolongation of the line to be swept by their fire; counter-batteries should have their crests nearly parallel to the line subjected to their fire. These conditions, when fulfilled, will save a great deal of labor in the construction of embrasures. Embrasure-batteries are to be preferred to barbette, but the embrasures must be hidden, if possible. Various devices are given by means of which the embrasures are concealed, and the gunners screened from the fire directed upon them. The general principles governing the construction of field-works and trenches apply to the construction of batteries. It is to be remembered that artillery-fire draws artillery-fire; hence a greater thickness is requisite for parapets and epaulements sheltering artillery than is required for the simpler works. The batteries forming the first artillery position may have weaker profiles than those of the second position. See *Batteries*.

ELEVATING-ARC.—The elevating-arc is used for such guns as the 10-inch and 15-inch. This consists of a strip of brass attached to the base of the breech parallel to the ratchets. It is graduated into degrees and parts of degrees, and a pointer, attached to the ratchet-post, indicates the elevation or depression of the piece. When the pointer is at zero, the axis of the piece is horizontal. Besides the graduation on the arc, the ranges in yards for the ordinary charges for shot and shell are given. In batteries for garrison and sea-coast defense, where the platforms are fixed, the line of metal may be considered as permanent; but with siege-guns, mounted on traveling-carriages, the wheels are liable to vary in position from unevenness of ground or unequal settling in newly-constructed platforms. This line is constantly changing, and approximates the higher wheel in proportion to the difference of level between the wheels; hence, to secure accuracy of fire, allowance must be made by observing where the shots strike and correcting the aim accordingly. Deviation from this cause is always towards the side of the lower wheel. All range-tables are made out with reference to the horizontal plane passing through the axis of the trunnions; when the object to be fired at is situated on a plane lower than this, an allowance must be made for this difference of level by deducting from the elevation laid down in the table of ranges.

The following table is calculated for cases in which the piece is *above* the object; it will also serve with sufficient degree of approximation for cases in which the piece is *below* the object, by simply reversing the method of application; i.e., by adding, instead of subtracting, the quantity due to the height and distance:

Distance.	Height.							
	1 Ft.	2 Ft.	4 Ft.	8 Ft.	16 Ft.	32 Ft.	64 Ft.	96 Ft.
Yds.	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′
1,000..	1.1	2.3	4.6	9 2	18.3	36.7	1 13.3	1 50
1,100..	1	2.1	4.2	8.3	16.7	33.3	1 6.7	1 40
1,200..	.9	1.9	3.8	7.6	15.3	30.6	1 1.1	1 31.7
1,300..	.9	1.8	3.5	7	14 1	28 2	56.4	1 24 6
1,400..	.8	1.6	3.3	6.5	13.1	26.2	52.4	1 18.6
1,500..	.8	1.5	3	6.1	12 2	24 4	48.9	1 13.3
1,600..	.7	1.4	2.9	5 7	11.4	22.9	45.8	1 8.7
1,700..	.7	1.3	2.7	5.4	10.8	21 6	43.1	1 4.7
1,800..	.6	1.3	2.5	5.1	10.2	20.4	40.7	1 1.1
1,900..	.6	1.2	2.4	4.8	9.6	19.3	38 6	57.9
2,000..	.6	1.2	2.3	4.6	9.2	18.3	36.7	55
2,100..	.5	1.1	2.2	4.3	8.7	17 5	34 9	52.4
2,200..	.5	1	2.1	4 2	8.4	16.7	33.3	50
2,300..	.5	1	2	4	7.9	15.9	31.9	47.8
2,400..	.5	1	1.9	3.8	7.6	15.3	30 6	45 8
2,500..	.4	.9	1.8	3.6	7.3	14.7	29.3	44
3,000..	.4	.8	1.5	3	6.1	12.2	24.4	36.7
3,500..	.3	.7	1.3	2.6	5.2	10.4	21	31.4
4,000..	.3	.6	1.1	2.3	4.6	9.2	18.3	27.5
4,500..	.3	.5	1	2	4.1	8.1	16.3	24.4
5,000..	.2	.5	.9	1.8	3.7	7.3	14.7	22

When the height of the piece above the water or horizontal plane is known, the angle of depression for different distances can be found thus: Find the angle for any height not given in the table, as follows: divide the given height into parts, which are found in the table, using the largest numbers possible; and add the angles corresponding to those parts, for the required distance. See *Pointing*.

ELEVATING-BAR.—A stout bar of iron with one end squared and made to fit into the ratchets on the breech of the piece for the purpose of giving elevation. It is operated as a lever, the fulcrum being the ratchet-posts of the carriage.

ELEVATING-EYE.—To facilitate the elevation and depression of the Armstrong land-service guns, an *elevating-eye* is screwed into the under side of the breech, at a suitable distance from the trunnions, for the adjustment of the gun, by means of an elevating-screw; the 40-pounder, however, has a somewhat different arrangement, having an elevating-screw and quoin.

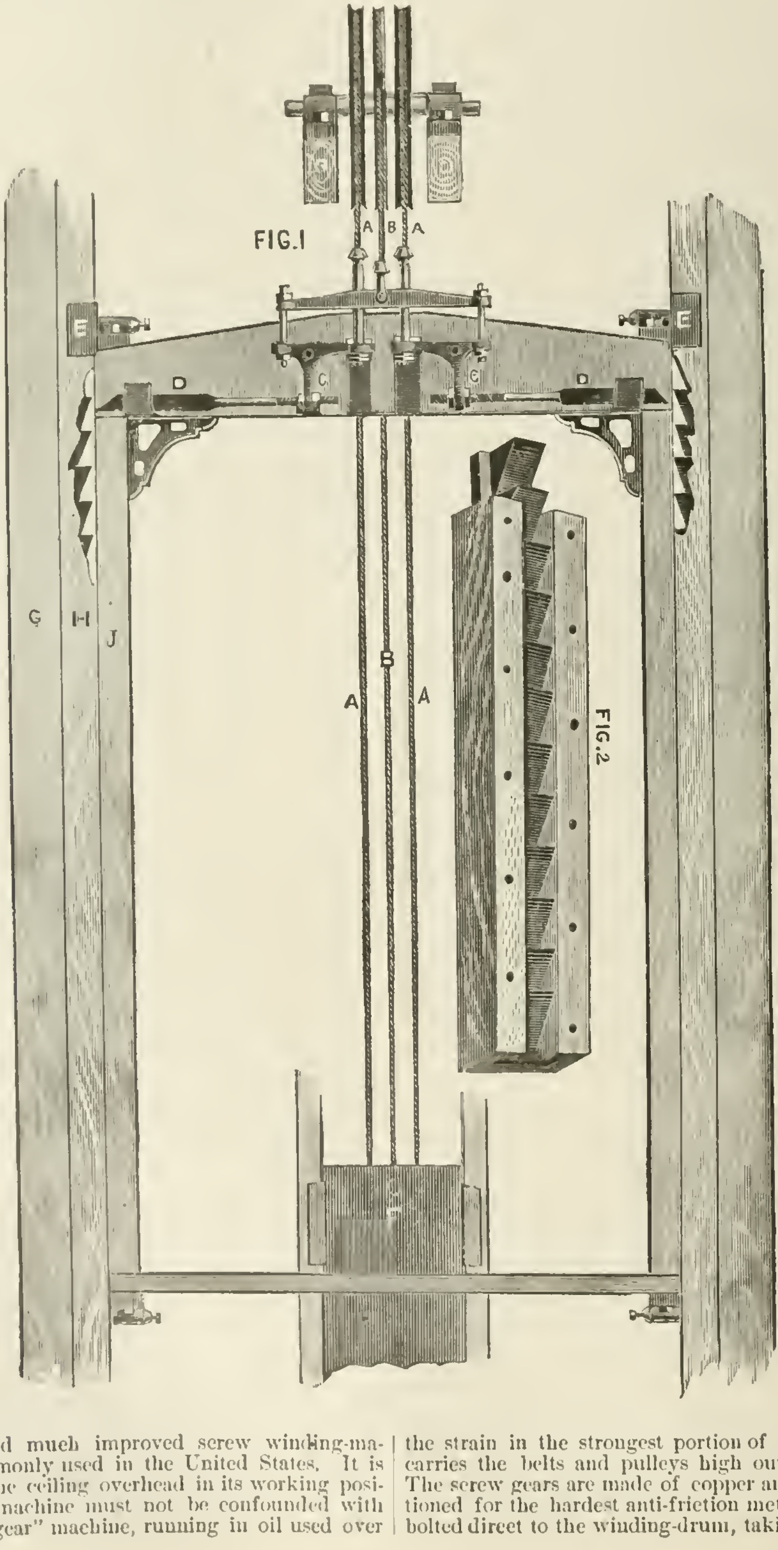
ELEVATING-GEAR.—Gearing variously contrived for elevating the breech of a gun. In the Gatling gun it consists of a screw whose lower part rests upon the trail of the gun, and whose upper part ends in a ball, working in a socket, on the under side of a brass casting. On the upper surface of the casting is a rib which works in a corresponding slot in a square brass plate screwed to the under side of the breech-casing. See *Traversing-gear*.

ELEVATING-SCREW.—A screw beneath the breech of a piece of ordnance to give the elevation or vertical direction to the piece. In field-pieces it is bedded in the stock immediately under the base-ring of the gun, which rests on the top of the screw. The screw is turned by four handles. The elevating-screw attached to the new iron carriages in England is known as the Whitworth pattern. Heavy gun-carriages, such as the wrought-iron standing or rear chock carriages, have the "ratchet-head and lever," with a modification in the chock-carriages, which have an oscillating instead of a fixed nut. In theodolites and other geodetical and astronomical instruments a similar contrivance is used for leveling the instrument.

ELEVATING-SIGHT.—The back sight of a gun or rifle which is raised, when it is found necessary, to elevate the piece.

ELEVATION.—In gunnery, the raising of the axis of the piece sufficiently high to enable the shot to range the required distance. In firing at a given object, the axis of the gun must necessarily be directed upon a point at a sufficiently vertical distance above the object to allow for the action of gravity, which causes the ball continually to descend after leaving the bore of the piece. The elevation of the axis of a gun is generally regulated by means of a tangent-scale, which is graduated in such a manner that the divisions on it correspond with the various ranges required from the gun. In geometrical and fortification drawing, *elevation* is the projection of the face of a work on a vertical plane by horizontal rays. It shows the height or depth of a work, and also its length, when the plane of projection is parallel to its face.

ELEVATOR.—Freight-elevators are now regarded as a business necessity by all manufacturers using several floors. They double the value of the upper stories for storage and other purposes, enable them to handle goods with much less help and in less time, and reduce the cost of manufacturing in the same proportion. These advantages are so self-evident that their use has become the rule in commercial centers. As a matter of safety, in all elevators, whether geared, screw, or hydraulic, all the essential parts, winding-machine connections and platform, should be stronger than the driving power, so that if the platform or its carelessly loaded freight should come in contact with a floor, or any unyielding obstruction, nothing will break, but the belts will slip or run off and do no harm; if a hydraulic elevator, the piston will stop in the cylinder. The power for hoisting may be obtained from various sources. As most foundries and construction-works are supplied with an abundance of steam or other power, they employ steel screw machines of sufficient lifting capacities, again and filled with dirt and accumulations to grind out the parts. The drive-shaft and screw are made from a solid cast-steel forging, cut and finished by special tools. The screw is run above (not under, as usual) the worm-gear, and thus concentrates all



A recent and much improved screw winding-machine is commonly used in the United States. It is secured to the ceiling overhead in its working position. This machine must not be confounded with the "worm-gear" machine, running in oil used over the strain in the strongest portion of the frame and carries the belts and pulleys high out of the way. The screw gears are made of copper and tin, proportioned for the hardest anti-friction metal. They are bolted direct to the winding-drum, taking no chances on the breakage of the shaft, or keys or set-screws getting loose. They are also fitted with an automatic stop-motion, which is adjusted to the height of the building, and prevents the winding-drum from making more than the number of revolutions required for the platform or car to travel from bottom to top, where it is stopped automatically, without any connection with the shifting-ropes. With the belt-shifter one belt only is moved at a time, which is much easier to operate and with less wear upon the belts than where both belts are shipped across wide pulleys, as is usually the case. The loose pulleys have long bearings lined with composition sleeves, and have large self-oiling chambers.

In a locality supplied with a system of water-works at a sufficient pressure, the hydraulic elevator presents many advantages over any other. The first cost is much less when compared with that of putting in steam-boiler and engine; the cost of running is much less than the cost of fuel and the services of an engineer; the objections to steam-boilers are avoided; the elevator is always ready, night and day; there is no waiting to get up steam, nor noise from fast-running engines, belting, or machinery. The hydraulic engine is very simple, strong, and durable, slow and noiseless in its movements, and requires little attention or repair. In localities not supplied with water-works an independent water-pressure may be provided on what is known as the "tank system." A water-tank of suitable size, made of tank-iron or cedar, is placed upon the roof of the building. Another of similar size is placed in the basement. Water from the upper tank is conducted by wrought-iron pipes direct to the hydraulic valve and engine below, the pressure of which supplies the power to raise the car. When the car descends, the water is discharged into the tank below. Here the problem of power comes in: to return the water again to the upper tank, using the same water over and over again. This is usually done by a steam-pump, working perfectly automatic, the steam being admitted and shut off according to the requirements of the elevator by the height of the water in the lower tank. In this system (as the pressure is invariably due to the height) buildings of four stories or more high will give the most satisfactory results.

The drawing shows what is known as the "gravity safety," a counter-weight provided for elevators subjected to heavy loads. Its principle consists in making the weight, used to balance the car, serve the purpose of safety also, by attaching it directly to the safety-pawls, ready to throw them out to engage the safety-ratchets, if the lifting rope or ropes should break. A A, Fig. 1, are two lifting-ropes. B is the rope attached to the weight, F. C C are two wrought-iron crank-levers, which swing on pivots and engage the two safety-pawls, D D. E E are the two guide-shoes, which run on the safety guide-ways, H. G is the guide-post.

It will be seen that, as the two lifting-ropes are attached to extremes of the crank-levers, C C, and the weight-rope to the other extremes (connected by the cross-lever), so long as the lifting-ropes maintain their hold they will keep the levers and pawls in the position shown in the drawing by the superior weight of the car; but should one or both of the lifting-ropes break or lose hold upon the weight-rope, always ready to act, it would instantly throw out the pawls to engage the safety-ratchets on the guide-posts, and lock the car.

Fig. 2 is an enlarged view of a section of the safety ratcheted guide-way, shown also at H, Fig. 1, with a portion of the wood casing cut away to show the iron ratchets. The object of this invention is to provide a smooth, even, noiseless guide or track for the platform or car while moving up and down; also to retain and hold the flanged iron safety-ratchets with increased strength and safety. By incasing the iron ratchets in or between the hard wood by the iron flanges as shown, and the wood screwed or bolted to the guide-posts, it forms the noiseless guide-way, and so holds, strengthens, and retains the latter that should it be broken it could not separate from the wood, but would still serve the purpose of safety-stops for the car. It might be found desirable to form the casing in two or more strips, united and placed, with relation to the ratchet sections, in any convenient or suitable manner.

The shaft to receive an elevator should always be constructed from four to six inches wider upon each side than the bottom of the car. This gives ample room for guide-ways, cables, counter-weights, etc. The shaft should extend through the roof and be lighted from the top, especially in passenger-elevators. All projections (in the shape of door-sills or pipes) into the shaft should be avoided; they are always elements of danger. The inside of the shaft should be as plumb and smooth as possible. Whenever the shaft is built of wood, the studding should be 2×6 feet, if possible, and 12 inches from centers, well and firmly bridged, and corners well tied together. The door-openings to the shaft, upon each floor, should be the width of inside of the car. This is necessary in freight-elevators to give ample access to car or platform. In passenger-elevators this space should be occupied by one stationary and one sliding door, with the upper panels of doors furnished with plate glass or wire screens. This gives a prominence to the elevator-entrance, and a much more pleasant appearance from without or within the car. The doors should slide as nearly flush with the inside of the car as possible, and be opened only from the inside by the attendant in the car.

In planning the position of an elevator, it is always advisable to enter the car from the same side on each floor, having but one door opening into the car, if possible. Cars with two door-openings, at right angles, calling for corner guide-posts, are more expensive, not so strong, and more liable to accidents.

ELF-ARROW-HEADS.—A name popularly given in the British Islands to the arrow-heads of flint which were in use at an early period among the barbarous tribes of Europe generally, as they are still in use among the American Indians, the Esquimaux of the arctic regions, and the inhabitants of some of the Islands in the Pacific Ocean. It was believed that elves or fairies, hovering in the air, shot these barbs of flint at cattle, and occasionally even at men. Thus, Robert Gordon, of Straloch, an accomplished country gentleman of Scotland, writing in 1654, tells how one of his friends, traveling on horseback, found an elf-arrow-head in the top of his boot, and how a gentlewoman of his acquaintance, when out riding, discovered one in the breast of her habit. He remarks that, although they are got by chance in the fields and on the highways, one who goes to look for them on purpose will search in vain. He adds that they are most commonly met with after showers—a circumstance which probably helped them in Germany to their names of "thunder-bolts" and "thunder-stones," and is easily enough explained. The rain, by washing away the earth in which they have been imbedded, makes them more readily perceptible to the eye, especially if the sunshine happens to fall upon them. Cattle dying suddenly in the fields were believed to have been struck by elf-arrows—a belief which yet lingers in Ireland, and perhaps in some secluded parts of Scotland. The elf-arrow-head was occasionally set in silver, so as to be worn on the person as a talisman, or had a hole drilled through it, so that it might be dipped in water, which, being thus endowed with healing virtue, was used sometimes as a wash, more commonly as a draught. As a talisman, the elf-arrow-head was believed to be most efficacious as a preservative from poison and witchcraft. The ascription of the flint arrow-head to the elves or fairies

Elf-arrow-head.

is but one of several instances of the disposition of a people to elevate or degrade the earlier races whom they vanquished or dispossessed into mythical beings, better or worse than mankind. Thus, in Greece and Italy the remains of the rude strongholds built by the Pelasgi came to be regarded as works of the fabled Cyclops, or one-eyed giants. So also, in Scotland, the sepulchral mounds of the aboriginal inhabitants were called "elf-hillocks;" and the vestiges of ancient plowshares which may be traced on heaths and hill-tops were called "elfin-furrows." Examples of elf-arrow-heads may be seen in most Museums of Antiquities. They fall to be more particularly described in a following page, under the head of FLINT IMPLEMENTS AND WEAPONS.

ELLIOT CARTRIDGE-BOX.—This box consists of two metallic plates mounted side by side on a common pivot, by which they are secured in a skeleton metallic frame covered with leather. They are fluted radially for the reception of twenty-four musket-cartridges, caliber .45. These flutings are so arranged that the heads of the cartridges may lie in an almost continuous row, while the points overlap each other in such a manner that the cartridges are mutually supported by the ends of their cases, the weight being thus taken off the point of the ball, and removing its liability to be driven into the cartridge by the repeated shaking of transportation. The box when used is to be worn over the left breast. When charged, it is rotated for firing by bringing with the fingers each cartridge in succession to an open notch in the periphery of the frame, beyond which it is kept from going by the interposition of the end of the rim, which is here turned down into a flap and serves to stop its further motion in this direction. Its return is prevented by a spring-pawl on the under side of a slide on the circumference of the frame. This slide, when pulled out, keeps the cartridge beneath it from accidentally falling out, and yet allows it to be used as a means of rotating the box, as soon as the cartridge next preceding has been picked out through the space left for its ready removal.

ELLIOT GUN.—A breech-loading small-arm having a fixed chamber closed by a movable breech-block, which rotates about a horizontal axis at 90° to the axis of the barrel, lying above the axis of the barrel and in rear, being moved from above. By cocking the hammer, it operates as a lever on the breech-block pawl, and at each movement alternately pushes and pulls against the lower arm of the breech-block and opens and closes the piece. After opening the piece the hammer falls forward, and resting upon the pawl prevents any motion of the block until the piece is closed, which is done by again bringing the hammer to the full-cock, where it is held by the rear end of the trigger. The piece is locked by the position of the breech-block and by its friction against the head of the cartridge when firing. It is also braced by the hammer falling behind a shoulder on the pawl, to prevent its movement as in opening. It is fired by the usual center-lock and a firing-pin in two sections, one of which moves with the block and the other remains in the frame. Extraction is accomplished by a lever pivoted below the chamber and worked through the intervening extractor-link by the movement of the hammer on the pawl. Ejection is effected by an auxiliary spring playing on a friction-roller eccentrically placed in the extractor. The guard is hinged at its rear end so as to afford a ready means of inspecting or cleaning the mechanism, and the lock is so constructed that the hammer cannot be let down slowly upon the firing-pin with the thumb.

This arm has been modified so that extraction may be caused by a bent lever of the usual form, and operated by the descent of the breech-block. In this modification the breech-block pawl is single and works within the cheeks of a slit hammer.

ELLIOT MAGAZINE-GUN.—This arm is provided with a reciprocating and rotating bolt for closing and locking the cartridge chamber by means of a handle in the usual way. It is also provided with a double tubular magazine, located in the butt-stock, the tubular chambers being arranged one over the other, and each provided with independent cartridge-propelling devices. The upper end of the revolving pawl is bent inward and works in a longitudinal groove cut in the side of the bolt; and where the bolt is rotated in locking and unlocking the arm it gives a vertical movement to the revolving pawl, which, being actuated by a suitable spring, causes the disk or ratchet to revolve one notch. On the face of the disk and over each alternate ratchet-tooth there is a cam. These cams and the free ends of a double feed-pawl are so arranged in relation to each other that the cams pass under and raise the ends of the feed-pawl alternately. Each time one of the ends of the feed-pawl is raised the line of cartridges under it is permitted to move forward until the ball of the first cartridge lodges in the recess between the carrier and bolt. In this position of parts the head of the first cartridge remains a little way in the mouth of the magazine, and the second one has not yet engaged the point of the feed-pawl. When the bolt is drawn back after firing, the magazine-spring forces the whole column of cartridges forward until the feed-pawl engages the head of the second one, and the first one is landed upon the carrier. When the backward movement of the bolt is completed the first cartridge is raised into the receiving-chamber by the carrier-spring. By this arrangement of parts the shock of arresting the forward movement of the column of cartridges is taken upon the carrier and bolt. In addition to the ordinary spiral magazine-spring there is an auxiliary spring in the bottom of each tubular space, the object of which is to cushion the blow of the column of cartridges upon the bottom of the magazine in case of heavy recoil or jolting when the magazine is full or nearly so, and thus prevent accidental explosions. The tubular spaces are provided with projections or shoulders on each side. These projections are so arranged that the cartridge-heads strike them alternately on each side, which causes the heads to vibrate laterally and prevents the cartridges from moving, from any cause, with dangerous rapidity, whereby accidental explosion is avoided. The butt-stock and tip-stock are made in separate pieces, being supported at their inner ends by cheek-pieces, under which they project. The handle of the bolt is attached to the rear end and has six curves, as follows: Backward and downward, which carry the handle back within reach of the thumb, while the index-finger is on the trigger; also curves downward, outward, and upward, to form a bed for the thumb to rest in. The end of the handle has also a downward curve over the side of the hand. During the manipulation of the arm the handle is grasped between the thumb and the side of the hand above the index-finger, from which it is not at any time released. At the moment of firing the bolt is held in the locked position by the thumb on the handle. In withdrawing the bolt the thumb is bent down a little forward of the lower end of the handle, and the act of returning and locking the bolt carries the index-finger back to the trigger, and the other three fingers to the wrist of the arm. See *Magazine-gun*.

ELLIPSE.—The name of a figure in geometry important from its being the approximate shape of the planetary orbits, and frequently appearing in the problems of gunnery. It is a curve of the second order, and is a conic section, formed by cutting a right cone by a plane passing obliquely through its opposite sides. It may be defined as a curve the sum of the distances of every point in which from two fixed points within the curve is always the same. These two fixed points are called the foci; and the diameter drawn through them is the major axis; the minor axis bisects the major at right angles. The distance of either focus from the middle of the major axis is the *eccentricity*. The less the eccentricity is compared with the axis, the nearer the figure approaches to a circle; and a circle may be considered as an ellipse in which the foci coincide.

There are various contrivances for describing an ellipse, called *ellipsagraphs* or *elliptic compasses*. The simplest method of description is to fix on a plane the two ends of a thread with pins in the foci, and make a pencil move on the plane, keeping the thread constantly stretched. The end of the pencil will trace an ellipse whose major axis is equal to the length of the thread.

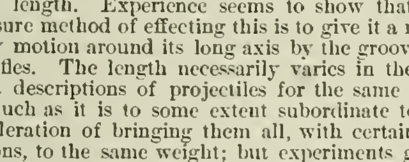
The equation to an ellipse, referred to its center as origin, and to its major and minor axes as rectangular axes, is $\frac{x^2}{a^2} + \frac{y^2}{b^2} = 1$, where a and b are the semi-major and semi-minor axes respectively. From this equation it may be shown by the integral calculus that the area of an ellipse is equal to πab, or is got by multiplying the product of the semi-major and semi-minor axis by 3.1416. It may also be shown that the length of the circumference of an ellipse is got by multiplying the major axis by the quantity

$$\pi\left(1 - \frac{d^2}{2^2} - \frac{3d^2}{2^2.4^2} - \frac{3^2.5d^2}{2^2.4^2.5^2} - \text{etc.}\right),$$

where $d = \frac{1 - 4b^2}{4a^2}$.

ELONGATED PROJECTILES.—The great improvements which have been made of late, in the accuracy and range of cannon, consist simply in the use of the elongated instead of the spherical form of projectile. To attain accuracy of flight and increase of range with an elongated projectile, it is necessary that it should move through the air in the direction of its length. Experience seems to show that the only sure method of effecting this is to give it a rapid rotary motion around its long axis by the grooves of the rifles. The length necessarily varies in the different descriptions of projectiles for the same gun, inasmuch as it is to some extent subordinate to the consideration of bringing them all, with certain exceptions, to the same weight; but experiments go to prove that a length of two calibers at least is necessary for very accurate firing, and it is desirable for good *vis viva*, or destructive effect on impact at any but very short ranges, to have the weight great in proportion to the caliber, or, in fact, to the surface of resistance, and of course this is favored by an increased length of projectile. As a rule, the best length for accurate firing with any ordinary twist has been found to be from two to three calibers.

The form of head is governed by two considerations, *flight* and *penetration*. The latter gives different forms in different instances. The question of flight affects all equally, and on this many experiments have been made, which have resulted in the general adoption of what is termed an *ogival* head, or figure generated by the revolution of an ogival or pointed arch about its axis. It has been found that the total pressure on a nine-inch spherical projectile, moving with a velocity of 1150 feet per second, is about 555 lbs. ANBM representing the spherical nine-inch projectile, and the total pressure on a hemi-



spherical-headed, elongated projectile of the same diameter represented by ACDBM, and moving with the same velocity, is 487 lbs., thus showing a difference of 68 lbs. total pressure. Now supposing the elongated projectile to move steadily, point first, the pressure on the respective heads, A, M, B, must be the same; therefore the difference of the total pressure, viz., 68 lbs., must be due to the difference of *minus pressure* on the bases ANB, ACDB respectively, thus showing that the form of base of a projectile materially influences the total pressure which it meets with when moving through the air at a high velocity. The total pressure on an ordinary ogival-headed projectile of 9 inches diameter, represented by ACDBM′, is only 389 lbs., thus showing the great difference of pressure, viz., 166 lbs., on an elongated ogilval-headed projectile and a spherical projectile of the same diameter when moving at the same velocity through the air. Another great advantage which the elongated projectile possesses over the spherical is that, for the same caliber, the momentum of the former is much greater, varying, of course, in proportion to their respective weights, which would be nearly three to one, depending on the length of the elongated projectile. Piobert says that the figure experiencing the least resistance from the air has a length five times its greatest diameter, with its largest section placed $\frac{2}{5}$ of the length from the hind part. The shapes of some of the Whitworth projectiles approach more nearly to this form than those of any elongated projectiles hitherto used. See *Projectiles*.

ELSWICK COMPRESSOR.—An arrangement for compressing friction-plates used to take up the recoil of gun-carriages upon their slides. The seven friction-plates arranged longitudinally under the carriage and attached to its lowest part have alternating between them six long flat bars attached at their ends to the slide by bolts passing through them, but allowing them a side motion. The plates and bars are tightly clamped by short rocking levers, the lower ends of which act on the outside plates. The levers are worked by collars on a threaded shaft, which catch their upper ends. The shaft is called the compressor-shaft, and has a handle or crank on the outside of each cheek or bracket; one is called the *adjusting-lever*, the other the *compressor-lever*. The first is used to give an initial compression to suit the charge, the other is operated by the recoil being forced down by a tripper on the slide.

ELSWICK GUN-WORKS.—The Elswick Works of Sir William Armstrong, at Newcastle-upon-Tyne, have produced the largest constructions in England of their well-known type, and from which sprang the modified form known as the Woolwich gun. We cannot here attempt to give a description of the Works in any general sense, but merely to notice a few features such as characterize them, or should be noticed by visitors to Elswick, especially engineers. We suppose the works to be traversed in the order adopted, as far as we understand, on the last Public Day.

Commencing at the northeast corner of the Works, the first objects of interest are the 6-inch and 40-ton breech-loading gun mounted in barbette. It is well to observe the system in action and the cover afforded to the detachment. Close to these guns is a shrinking-pit for ordnance from the 100-ton gun downwards, also nineteen gas-producers for furnaces. The shops then may be taken in the following order·

Coiling.—The largest section of bar has been 12 by 10 inches; length of coiling-furnace, 180 feet; gas-furnace for heating barrels, also for tempering, with an oil-well 50 feet deep, over which stands a hydraulic hoist.

Forge.—The large hammer here, made by Thwaites & Carbutt, Bradford, has a 48-inch cylinder and 12 feet stroke; weight of piston and hammer-head, 35 tons. Blast smelting-furnaces, one furnace building, two in work, and running from 900 to 1000 tons a week, chiefly No. 1, 2, and 3 pig, made from Spanish and Elba ores, most of it sold for steel-making. The blast is at present heated by horseshoe pipes, but Cowper's heating-stoves are in course of erection; temperature of blast, from 750 to 800 —about the melting-point of zinc. The engine for the furnaces is made by the firm.

Carriage-shed.—There are band-saws cutting iron which may be noticed, and Albini carriage on short recoil and self-running-up system.

Projectile-store.—Containing the finished projectiles. These are chiefly made with bands only up to full diameter, which saves work, and leaves to the projectile the strength of the uninjured skin of the casting. The Palliser chilled projectiles will be generally found with sharp-pointed heads struck with two diameters ogival.

Foundry.—Containing the ten cupola-furnaces, of which four are generally in work. Forty tons is about the maximum weight of casting made in the foundry—a much larger one, such as the bed of the steam-hammer, weighing 137 tons, being cast on its own ground. The system of hydraulic cranes should be noticed. They are fixed so as to work in pairs, or three together, for heavy work.

Engines.—Near this are the engines for the East Works, and also those for the West Ordnance-works. Horizontal double Corliss engines are employed, with four boilers; three working at a time. Juke's bars and system of stoking is applied to all. The *Jetty* may probably be conveniently visited next, near which are more horizontal engines, 100 horse-power, working on the accumulators; the water-pressure maintained is about 700 pounds per square inch. Five or six locomotives are generally employed in the works. On the east end of the jetty are two fixed hydraulic cranes for lifting 5 tons and 30 hundredweight; and between them large hydraulic shears, made by Day & Summers, worked by a direct-acting hydraulic cylinder, 40 feet stroke, lifting 120 tons. The bag-leg moves so as to bring the lifting-cylinder about 30 feet out, 15 feet inboard of a vessel. The foot is moved by a screw 50 feet long, with hydraulic engine and gear, with three different powers. Along the jetty run pipes with hydrants from 18 to 36 feet apart, on which work five movable cranes, each lifting about 30 hundredweight, being placed in position to suit the holds of the vessels by means of telescope-tubes attached to the nearest hydrants.

The finishing-shop may be taken next in order. The proportions of new-type guns should be noticed also; the breech-loading fittings, and apparatus for firing by electricity and also mechanically. One shop is for small machine-work, completing Gatling machine-guns, hydraulic valves, etc. Another contains planing-machines, etc. Others are constructed for turning, finishing, and boring work, commencing on the solid ingot. At the east end guns are bored vertically in a pit 23 feet deep. The finest lathe is one of Whitworth's for turning, boring, screw-cutting, and rifling, taking a job 44 feet in length, 36-inch centers. There is also a convenient one made by Fairbairn, Kennedy & Naylor, modified at Elswick, taking a chuck job 20 feet in diameter, 4 feet 6 inches long, or a job 34 feet long and 8 feet in diameter. It is fitted with slide-rests on independent beds. There are also chambering and rifling machines. In another shop, crank-shaft and gun work, coil-welding, etc., are performed. The steam-hammers, from 24 tons to 15 hundredweight, are chiefly Morrison's make. There is a great variety of small machinery, for turning and boring out short coils; also a large endless band-saw, 1¾ inch wide, which cuts directly through iron cylindrical work about 16 inches in diameter. Its speed is from 76 feet to 129 feet per minute.

It will be seen that the facilities of these works are ample in every respect for ordnance-constructions; and when we come to consider the decidedly advanced progress in the adaptation of steel in its strongest form—ribboned—in gun-constructions of light weight combined with great power, it must be admitted that in the pure question of the building up of guns to resist the drafts upon them, especially by tangential strains, far beyond standard limits in England, Sir William Armstrong & Co. are farthest advanced as the pioneers in Great Britain of a system destined, probably, to solve in the most satisfactory manner the problemn of all heavy gun-construction, in the present state of the art, in producing the metals deemed most suitable for making sound and reliable ordnance. See *Armstrong Gun* and *Ordnance.*

EMBAR.—The command, in heavy-artillery practice, directing that the handspikes be placed in positions for moving the piece and the carriage; as, for example, when it is wished to move a mortar *in battery*, the four cannoneers face towards the epaulement and EMBAR: Nos. 1 and 2 under the front maneuvering-bolts, and Nos. 3 and 4 under those in rear, engaging the butts of their handspikes about three inches; Nos. 1 and 3 hold the small end of their handspikes in the left hand, Nos. 2 and 4 theirs in their right. All being ready, the gunner commands, HEAVE, and repeats it as often as may be necessary. As soon as the piece is on the middle of the platform, he commands, HALT: all unbar, and resume their posts.

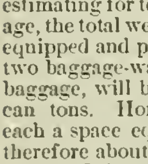
EMBARGO.—A temporary order to prevent the arrival or departure of ships. It may apply to vessels and goods, or to specified goods only; it may be general or special; it may apply to the entering only, to the departure only, or to both entering and departure of ships from particular ports; and lastly, although issued by the Admiralty in England, it would be equally an embargo if issued by any other competent authority. Such embargoes are generally connected in some way or other with a state of war between two countries.

EMBARKATION.—In loading vessels with stores for a military expedition, the cargo of each should be composed of an assortment of such stores as may be available for service in case of the non-arrival of others; and they should be placed on board in such a manner that they may be easily reached in the order in which they are required for service. Each storeship should be marked, at the bow and stern, on both sides, in large characters, with a distinctive letter and number. A list is to be made of the stores on board of each vessel, and of the place where they are to be found in it; a copy of this list to be sent to the chief officer of the proper department in the expedition, or at the place of destination. If the disembarkation is to be performed in front of the enemy, some of the field-pieces should be so placed that they can be disembarked immediately with their carriages, implements, and ammunition; also the tools and materials for throwing up temporary intrenchments on landing. Some vessels, distinguished by particular signal, should be laden solely with such powder and ammunition as may not be required for the immediate service of the pieces. Boats of proper capacity must be provided for the disembarkation, according to the circumstances in each case. It may be necessary to establish temporary wharves on trestles, and to erect shears, cranes, or derricks. On a smooth sandy beach heavy pieces, etc., may be landed by rolling them overboard as soon as the boats ground, and hauling them up with sling-carts. When the embarkation takes place from a wharf, and the vessel is not too high, it is best to use gang-planks and lead the horses on board. The gang-plank leading up from the wharf to the gunwale should be about 20 feet long by 10 feet wide, and be made very strong. This width admits of its being used for gun-carriages. It should be provided with ropes at the corners, rollers, side-rails, and boards upon the sides to prevent the horses from getting their feet over the edges. Another similar gang-plank, but not so long, leads from the gunwale to the deck, the two being securely fastened together by their ropes. These gang-planks should be carried by the vessel, ready for disembarking. Every provision for this latter operation should be thoroughly looked after before starting on the voyage. When it is not practicable to use gang-planks, the horses are hoisted on board by means of a sling and lifting-tackle. Five men are required to sling a horse quickly and well. One man holds the head-guy, which is attached to a neck-collar; two men, one on each side of the horse, pass the sling under his belly; both then hold up the ends over his back, passing the long loop through the shorter one and hooking on the eye of the former to the lifting-tackle, continuing to hold up the sling until the horse's legs leave the ground; another man stands at the breast and fastens the breast-rope, while the fifth stands at his rump and fastens the breech-rope. The officer superintending commands, "Hoist away." The first man slacks away at the guy-rope, holding it just sufficiently taut to keep the horse's head steady. When hoisting, no delay should be permitted; it should be done in the shortest time compatible with safety. At the commencement, after a certainty that all is right, it should be done rapidly, to raise the horse off his feet and free him from surrounding objects before he has time to do any injury by kicking. After attaining the necessary height, he is carefully and steadily lowered to the deck. Care should be taken to have two or three careful and active men stationed to seize the horse and prevent his plunging until the slings are removed. While one holds him by the head-stall, another rapidly unhooks the tackle-purchase, and two others let loose the breech and breast bands or ropes. When the horses are to be lowered through a hatch to a deck below, the combings of the hatch, as well as stanchions about it, should be well padded. As an additional precaution, a head-collar should be provided, with a large pad on top to prevent injury should the horse strike his head against the deck-beams when lighting on his feet. Everything being in readiness and skillfully managed, an average lot of one hundred horses can be hoisted on board in from two to three hours. Hatches for horses must be at least 10 by 10 feet.

Allowing 1100 pounds as the average weight of artillery-horses and 150 pounds as that of men, and estimating for ten days' supply of food, water, and forage, the total weight of a field-battery of six pieces, fully equipped and provided for field-service, and including two baggage-wagons loaded with camp-equipage and baggage, will be 329,000 pounds, or about 165 American tons. Horses embarked without stalls require each a space equal to 3.5 tons, marine measurement; therefore about 550 tons will be required for the horses alone. It is thus seen that the actual weight of a battery forms but a small proportion of the shipping tonnage required for it. The class of seagoing steamers usually chartered for transportation service are those that ply between points along the seaboard. They are generally propellers, and vary in tonnage from one to two thousand tons. Owing to the fact that a considerable part of their room is usually taken up with passenger accommodations, they are seldom able to carry more than one full battery. A steamer of 2000 tons burden, with a free spar and main deck, is capable of carrying two complete batteries. See *Transports*.

EMBATERION.—A war-song of the Spartans, accompanied by flutes, which they sung marching in time, and rushing on the enemy. The origin of the *embaterion* is lost in antiquity.

EMBATTLE.—To arrange in order of the battle; to draw up in array, as troops for battle; to furnish with battlements.


Embattled.

EMBATTLED.—*Embattled*, or *imbattled* (called also *crenellé*), is one of the partition-lines in Heraldry, traced in the form of the battlements of a castle or tower. A bordure embattled is often given as a difference to any member of a family who is, or has been, a soldier. See *Heraldry*.

EMBEZZLEMENT.—Any person in the military service of the United States who makes or causes to be made any claim against the United States, or any officer thereof, knowing such claim to be false or fraudulent; or who presents or causes to be presented to any person in the civil or military service thereof, for approval or payment, any claim against the United States or any officer thereof, knowing such claim to be false or fraudulent; or who enters into any agreement or conspiracy to defraud the United States by obtaining, or aiding others to obtain, the allowance or payment of any false or fraudulent claim; or who, for the purpose of obtaining, or aiding others to obtain, the approval, allowance, or payment of any claim against the United States or against any officer thereof, makes or uses, or procures or advises the making or use of, any writing, or other paper, knowing the same to contain any false or fraudulent statement; or who, for the purpose of obtaining, or aiding others to obtain, the approval, allowance, or payment of any claim against the United States or any officer thereof, makes, or procures or advises the making of, any oath to any fact or to any writing or other paper, knowing such oath to be false; or who, for the purpose of obtaining, or aiding others to obtain, the approval, allowance, or payment of any claim against the United States or any officer thereof, forges or counterfeits, or procures or advises the forging or counterfeiting of, any signature upon any writing or other paper, or uses, or procures or advises the use of, any such signature, knowing the same to be forged or counterfeited; or who, having charge, possession, custody, or control of any money or other property of the United States, furnished or intended for the military service thereof, knowingly delivers, or causes to be delivered, to any persons having authority to receive the same, any amount thereof less than that for which he receives a certificate or receipt; or who, being authorized to make or deliver any paper certifying the receipt of any property of the United States, furnished or intended for the military service thereof, makes, or delivers to any person, such writing, without having full knowledge of the truth of the statements therein contained, and with intent to defraud the United States; or who steals, embezzles, knowingly and willfully misappropriates, applies to his own use or benefit, or wrongfully or knowingly sells or disposes of any ordnance, arms, equipments, ammunition, clothing, subsistence stores, money, or other property of the United States, furnished or intended for the military service thereof; or who knowingly purchases, or receives in pledge for any obligation or indebtedness, from any soldier, officer, or other person who is a part of or employed in said forces or service, any ordnance, arms, equipments, ammunition, clothing, subsistence stores, or other property of the United States, such soldier, officer, or other person not having lawful right to sell or pledge the same, shall, on conviction thereof, be punished by fine or imprisonment, or by such other punishment as a Court-Martial may adjudge. And if any person, being guilty of any of the offenses aforesaid, while in the military service of the United States, receives his discharge, or is dismissed from the service, he shall continue to be liable to be arrested and held for trial and sentence by a Court-Martial, in the same manner and to the same extent as if he had not received such discharge nor been dismissed.

EMBLEE.—A prompt, sudden, and vigorous attack which is made against the covered-way and outworks of a fortified place.

EMBOSSING.—The art of producing raised figures upon various substances, such as paper, leather, wood, metals, etc. This is usually effected by pressing the substance into a die, the kind of die and mode of applying the pressure being modified according to the nature of the design and the properties of the substance to be embossed. Sheet-metal is embossed by stamping it between a pair of steel dies, one in relief, the other in intaglio. See DIE-SINKING. When the pattern is a deep one, several pairs of dies are used, and several blows given with each, the metal being occasionally annealed. The first stamping produces a crude resemblance to the final design, of moderate depth; successive stampings bringing up more of the details, and giving increased depth. The upper die is usually raised by a rope attached over a pulley to a stirrup, in which the workman places his foot; he draws his foot down to raise the heavy die to the required height, and then suddenly releases the pressure of his foot from the stirrup, when the die descends by its own weight. While thus raising the die with his foot, he adjusts the work in its place with his hands. Smaller work is embossed with a screw-press, the lever of which is turned with one hand, while the work is placed under the dies and removed by the other. Paper and card are embossed in a similar manner, but the dies are frequently of brass, sometimes of copper electro-deposits, suitably backed. The counter-die is commonly made of soft metal, card- or mill-board, pressed into the metal intaglio die until a sharp impression is produced. The paper or card is well damped, and a fly-press is generally used.

EMBOWED.—The heraldic term used for anything which is bent like a bow. A sinister arm couped at

Embowed. Counter-embowed.

the shoulder is *embowed*. When the arm is turned the reverse way it is said to be *counter-embowed*.

EMBRASSEUR.—A piece of iron which grasps the trunnions of a piece of ordnance when it is raised upon the boring-machine to widen its caliber.

EMBRASURE.—The embrasure is an opening made in the parapet for a gun to fire through. The bottom of the embrasure, termed the *sole*, is 2 feet 9 inches, or from 4 to 6 feet above the ground, on which the wheels of the carriage rest, according to the size of the gun and the kind of carriage. It usually slopes outward to allow the gun to be fired at a depression. The base of this slope should never be less than six times the altitude. In most cases it may be horizontal, or even have a slight slope to the rear. The interior opening, termed the *mouth*, is from 18 to 36 inches wide, according to the caliber of the gun, and is of a rectangular or trapezoidal form. The line which bisects the sole in the direction of the line of fire is called the *directrix*. The sides of the embrasure are termed the *cheeks;* these widen out towards the exterior, which widening is termed the *splay*, the inclination upon each side from the directrix being one upon ten. They furthermore have an

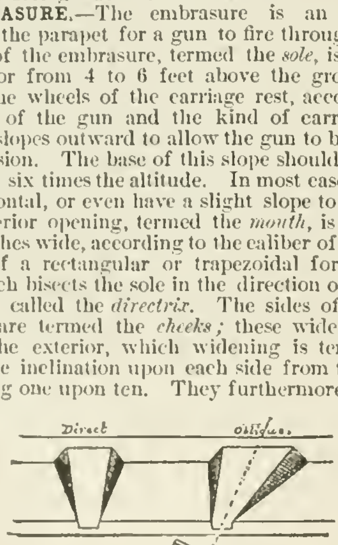


Fig. 1.

inclination outwards from the vertical; this inclination, at the line of the exterior crest, is three upon one. When the directrix is perpendicular to the interior crest, the embrasure is termed *direct;* when oblique, the embrasure is termed *oblique*, Fig. 1. In order that the part of the embrasure which is next to the muzzle of the gun may be nearly of the same width in both the direct and oblique embrasures, the mouth of the latter is wider in proportion to the obliquity. Embrasures are revetted with the same material and in the same manner as the interior slope.

If the exact position for the embrasure is known, it is best to lay it out and make it while the parapet is being constructed. As soon as the latter is built up to the sill of the future embrasure, a light stake is planted in line with the interior slope on each side of the directrix, in such position as to represent the sides of the mouth of the embrasure; a strip is nailed across at the proper height to represent the sill, and another above on the line of the interior crest. The earth being smoothed off to give the desired slope to the sole, the directrix is marked out on it by means of a cord; the splay of the cheeks is obtained by giving the sides an inclination of one tenth with the directrix. These lines being laid off on the sole, the revetment is placed along them and is given an inclination corresponding with the two profile stakes at the mouth, and three upon one at the exterior crest. Should gabions be used for revetting the cheeks, fascines are first partly imbedded along the edges of the sole, and the gabions placed on them in such manner as to obtain the proper flare. The gabions are held in position by being anchored with telegraph-wire to a beam of timber imbedded in the parapet parallel to and about 8 feet from the cheeks of the embrasure. The beams are held by securing stakes. Revetments made of other material are secured in a similar manner. This precaution should be thoroughly looked after in the first instance, because when the revetment is broken by the blast of the gun or the shots of the enemy it is difficult to repair it, and the necessity for repairing would probably come at a time when it could not be done. If the embrasure is to be cut out after the parapet is completed, the mouth is marked off with stakes and strips as before; the earth is removed so as to obtain

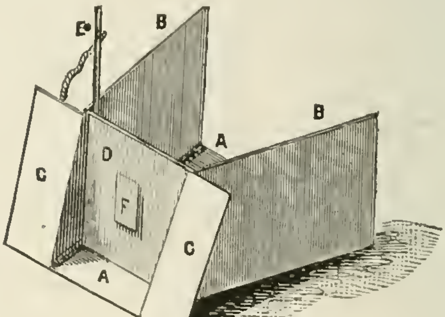


Fig. 2.

Isometrical view of wrought-iron casing for throat of embrasure and door or mantelet of same. A, sole-piece revetted to cheek-pieces, B, at the angles; C, front-pieces; D, door hung on horizontal angle at top; E, Lever with cord attached to pull up the door; F, slot in the door for rammer.

approximately the sole, which is then laid off and the work completed as just described.

The sole of the embrasure should be secured from being worn away by the blast with boards, poles, or some similar material running lengthwise with the embrasure. Raw-hides will greatly assist in preserving the revetments of the cheeks from the effects of abrasion produced by firing. For this purpose the hide, while green, is stretched, with the flesh side outward, over the part to be protected, and is there confined by stakes driven through it into the parapet. The best method, however, for securing the mouth of the embrasure, and the sole and sides for 5 or 6 feet from the mouth, is a lining made of ½-inch boiler-iron, Fig. 2. The plates are cut to the proper form to fit the sole and cheeks, and are fastened together with angle-irons and rivets. Wings, about a foot wide, extend out on each side against the interior slope to prevent the lining from being moved to the front by the blast. A round bar of iron passes across the top about 18 inches from the throat; to this a door of sheet-iron is suspended, forming a mantlet against musketry. In the center of this door is a cut or slot, about a foot high and 6 inches wide, for the double purpose of allowing the rammer to pass through while loading the piece, and for sighting it. A vertical lever of wood or iron is fastened to one side of the door; to this a rope is attached, so that by pulling on it the door is thrown up to allow the piece to be fired.

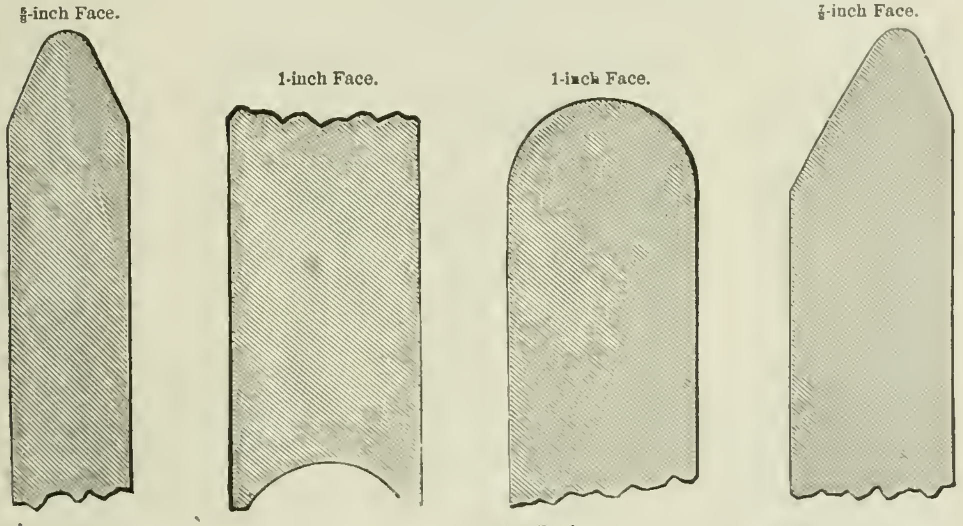
The advantages of embrasures is that the men and guns are less exposed than in a barbette-battery. Their principal defects are: they have a very limited field of fire; they weaken the parapet, and present openings through which the enemy may penetrate in an assault. Owing to their limited field of fire, they are generally used for the protection of particular points, as to flank a ditch, protect a salient, enfilade a road, etc. The most suitable position for them in a work is on the flanks. See *Direct Embrasure* and *Oblique Embrasure*.

EMBROCHER.—A common and vulgar term used among French soldiers to signify the act of running a man through the body; literally, *to spit him*.

EMERY.—A variety of corundum, or of the same mineral species of which corundum and sapphire (with oriental ruby, etc.) are also varieties. It agrees with them very perfectly in composition, hardness, and specific gravity; but is dull, opaque, and not crystallized, sometimes of a grayish black and sometimes of a blue color. It occurs both massive and disseminated. Its masses, although very compact, have a somewhat granular structure. It is found in several parts of Europe, in Asia Minor, Greenland, etc., generally in masses scattered through aqueous deposits, but in one locality in Saxony in beds of steatite in a schistose rock. The emery of commerce is chiefly obtained from the Island of Naxos. Being very hard, it is much used for grinding glass and polishing metals and other hard substances. It is found in lumps, having a granular structure. It is composed of alumina, oxide of iron, and silica, with a little lime, in proportions varying considerably with different specimens. The following may be taken as an average: alumina, 82; oxide of iron, 10; silica, 6; lime, 1½.

It is prepared for use by first breaking it into lumps about the size of a hen's egg, then crushing these to powder by stampers. It is then sifted to various degrees of fineness, which are numbered according to the meshes of the sieve. Plate-glass manufacturers and others separate emery-powder into different degrees of fineness by the method of *elutriation*. A number of copper cylinders of graduated capacities are placed in a row, and filled with water; the emery, churned up with an abundance of water, is admitted by a pipe into the smallest, it then passes to the next in size, and finally flows from the largest; and thus, as a given quantity of water with emery suspended in it passes in equal times through vessels of varying capacities, the amount of agitation will obviously be greatest in the smallest vessel, least in the largest, and in like proportion with the intermediate; the largest particles, therefore, sink in the smaller vessel, and so on till only the very finest will reach the largest vessel. In this manner any number of gradations of fineness may be obtained, according to the number and sizes of the vessels. Elutriation in oil or gum-water is sometimes used on a smaller scale, the emery being stirred up in the liquid, and portions poured off at different intervals of time, the finest being, of course, the last to settle. The use of the oil or gum is to make the subsidence take place more slowly. Emery thus prepared is used for a great many important purposes in the arts. Being next in hardness to diamond-dust and crystalline corundum, the lapidary uses it for cutting and polishing many kinds of stone. Glass stoppers of all kinds are ground into their fittings with it. Plate-glass is ground flat by its means; it is also used in glass-cutting, and in grinding some kinds of metallic fittings. When employed for the polishing of metals it has to be spread on some kind of surface to form a sort of fine file. *Emery-paper*, *emery-cloth*, *emery-sticks*, *emery-cake*, and *emery-stone* are various contrivances for such purposes.

Emery-paper is made by sifting emery over paper which has been covered with a coating of glue. It is used either by wrapping it round a fine file or a stick, or in the hand, according to the form of the work. Emery-cloth is made like emery-paper, with coarse calico substituted for paper. The emery does not adhere so well as to paper, and it is therefore not used by metal-workers, who work emery-paper till smooth with wear, but is chiefly used for purposes where the hand alone is used and paper would tear. Emery-sticks are used for the same purposes as emery-paper wrapped round files; they are made of deal sticks shaped like files, then glued over, and dipped once or twice in a heap of emery. Emery-cake is a compound of beeswax, suet, and emery, melted and well worked together. It is applied to buffing-wheels, etc. Emery-stone is a kind of earthenware mixed with emery, formed by pressing a mixture of clay and emery into

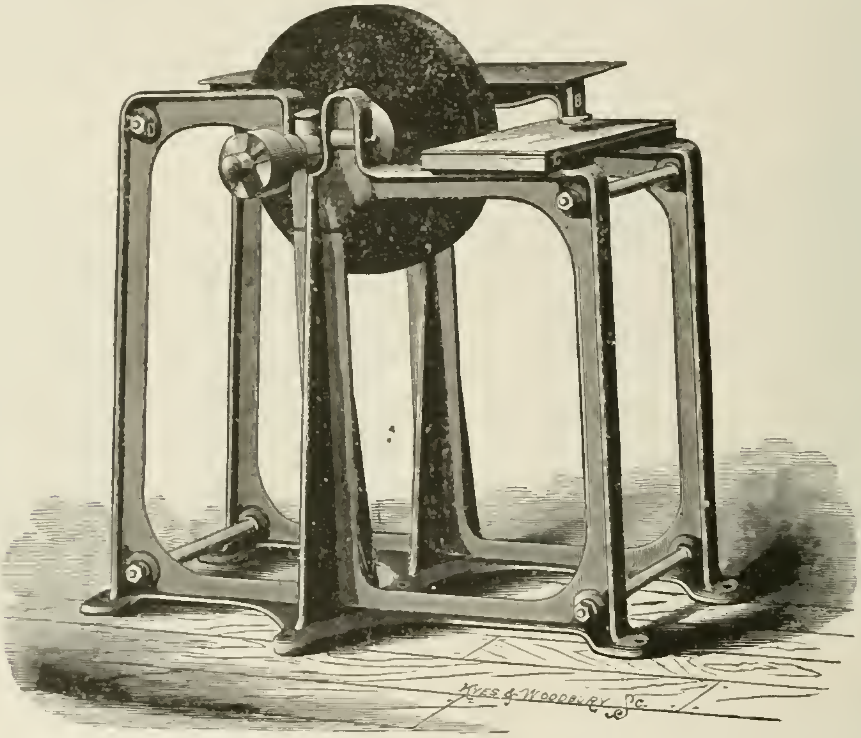


Faces of Tanite Wheels.

suitable molds, and then firing like common earthenware. It is molded into wheels, laps, etc. Its hardness and cutting power are very considerable. See *Polishing*.

EMERY-GRINDER.—An emery-wheel mounted in a stand, to be used as a grindstone. It may be considered as such, indeed, the mineral corundum with a matrix of gum-resin, glue, vulcanite, etc. The Tanite emery-grinding machinery is standard in the United States and Canada. The French, Belgian, Russian, and Australian Governments have also been large consumers, and even in the works of the Chinese and Japanese Governments Tanite emery-wheels and grinding-machines are largely employed.

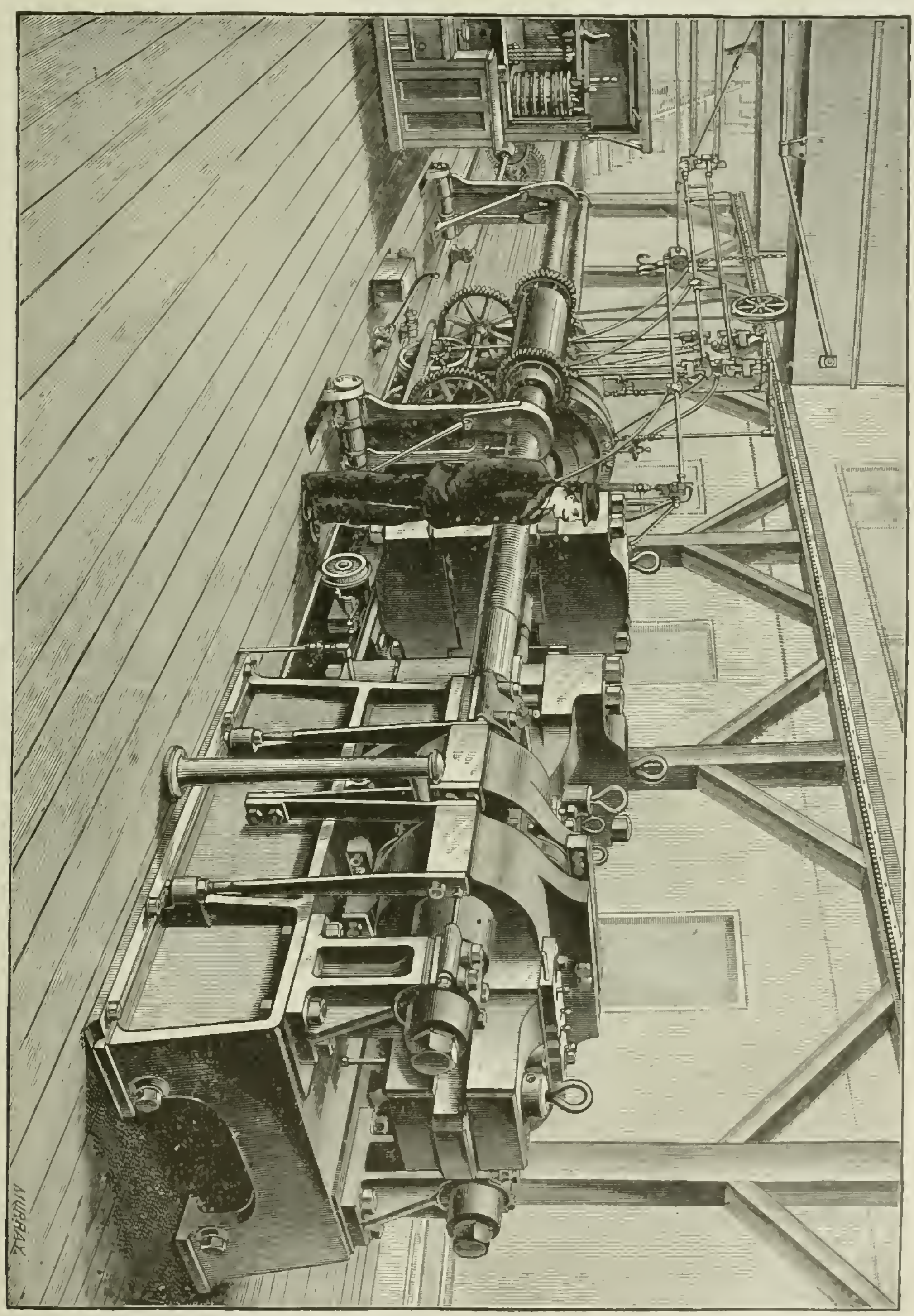
The drawing shows a single-wheel emery-grinder much used in arsenals. Hitherto, among the great variety of such machines, very few have been built to carry exclusively one large wheel. In machines which carry two wheels there is a certain amount of difficulty in providing solid and convenient rests at of these rests are accurately faced with a Tanite wheel running on an emery-planer. The back of the machine stands 5 inches higher than the front, and on the brace rod, D, which connects the upper back corners of the side frames, swings the rest, B, depending for its rear support on the brace-rod, D, and resting in front by a foot on the rest, C. It bridges over the side flange of the emery-wheel, and being a wide, long, substantial rest, allows of work being conveniently held and ground on the flat side of the emery-wheel. Owing to the weight of this rest, B, it remains firmly in position without being held by nuts or set-screws, and as it swings loosely on the brace-rod, D, it can in a moment's time be moved out of the way and be left hanging down at the back of the machine, or lifted up and placed in position. The spindle of the machine is of steel, and is 1¼ inch in diameter at the eye on the mandrel-hole of the wheel. The bearings are long, and are lined with Babbitt-metal. By far the larger proportion of Tan-



Emery-grinder.

the sides of the wheel. This is due to the fact that the emery-wheels overhang the bearings. The special object in designing the machine here illustrated, the manufacturers declare, was to make it equally convenient to use the wheel on the face and on the side. In machines previously built the *side* rests were attached to rest-sockets, and several nuts had to be carefully adjusted before the rests could be secured in their proper position. This grinder is designed to carry an emery-wheel of 20 inches diameter, and of any desired thickness from 1 to 4 inches; 20 by 2½ or 3 inches is the most suitable size. The front of the machine stands at such a height that the rest, C, when laid upon it, brings the metal which is to be worked exactly at the center of the emery-wheel, which is the proper point of contact when the face of the wheel is used as the cutting agent. The rest, C, is of cast-iron, and is 20 inches long by 8 wide. It is shown in the drawing as being faced with a steel plate (saw-steel), which was the original method of making these rests; but more recently all ite wheels are square (or plane) faced. As a rule, the wider-faced ones are used for surface-work, and the narrower for edge work. We give a few diagrams, on page 555, of shapes most frequently used in the arsenal. Of course wheels of any desired face can be made any diameter; but wheels so thin as ⅜-inch face should not be more than 12 inches in diameter, nor wheels of ¼-inch face more than 8 inches diameter. It is difficult to get wheels so thin of even temper if of a larger diameter; moreover, they are liable to warp, and to be broken by heavy side pressure. These shapes are easily obtained by turning square-faced wheels with diamond tools. See *Brass-fitting Machine, Exhauster, Grinding-machine, Gummer*, and *Pony Planer*.

EMERY TESTING-MACHINE.—This machine, the like of which for capacity, accuracy, durability, and general perfection of details is not known, is in possession of the United States Government, and is placed at the Watertown Arsenal in Massachusetts. The engraving on the opposite page shows a perspective view of the machine, and will aid in giving an exact understanding of its construction and the manner of operation. The problem before the inventor of this famous machine was one of no small difficulty. Briefly stated, it was:



Emery Testing-machine.

1. To construct a machine with the capacity of testing specimens for tension or compression up to a breaking-strain of 800,000 lbs., while at the same time the machine should be of such delicacy as to accurately show the strain required to break specimens no stronger than a single horse hair. 2. That the machine should have the capacity of seizing and giving the necessary strains to the specimens, from the minutest to the greatest, without the construction of a multitude of special appliances to suit the numerous changes of form and size in which materials to be tested are presented. 3. That the machine should be

able to give these strains and receive the shocks of recoil produced by the rupture of the specimen without injury. The difficulty of this requirement may be appreciated by considering that when a test to the full capacity of the machine is made, the scale, upon the breaking of the specimen, receives by recoil an *instantaneous load of* 800,000 *pounds*. The machine and scale must be so constructed as to bear this load placed upon it instantaneously, and bear it so perfectly that the next moment it will correctly show a load of a pound without any adjustment whatever. 4. That the machine should be so constructed that the specimen, while undergoing strain, may be readily accessible for the purpose of observing minutely the care being used in general throughout the whole machine.

In the article WEIGHING-MACHINE will be noticed the means which Mr. Emery employed in indicating loads or strains of all descriptions with an accuracy hitherto unknown. In this article we will see how a system of diaphragms can be applied to the weighing of the work of a testing-machine, and also notice what means the designer has adopted to obtain a machine entirely free from back-lash when the specimen breaks. The apparatus consists of two parts. The first is the machinery for putting strain upon the specimen, whether of compression or tension. In its essential features this consists of two screws carrying

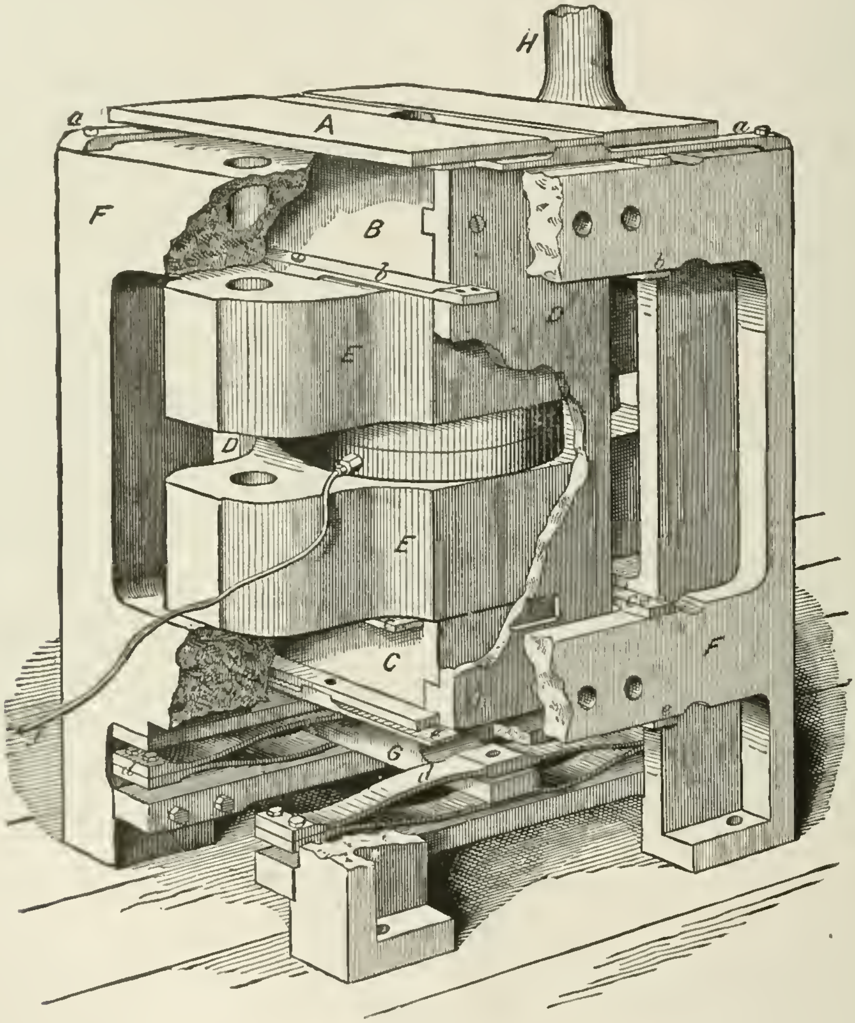


FIG. 1.

changes taking place with the changes of the strains or loads applied to the specimen. 5. That the machine should be so constructed as to be readily operated without excessive cost. The machine, after being erected, had applied to it a test-load of one million pounds, which it seemed to bear with the utmost ease. Before describing the machine, it is well to remark that all the working parts in general were at their working bearings, fitted to gauges to within less than one thousandth of an inch. For instance, the main screws, which are 48 feet long, were dressed to gauges throughout their whole length, and then the threads on them cut to gauges, the threads in the nuts being carefully gauged to match them, the same a straining-beam, to which a hydraulic cylinder is attached. This cylinder furnishes the power for compression or extension. These screws are attached to a frame in which a pair of beams are placed to furnish the abutments for resisting the power. Whether the strain is tensile or compressive, it results in compressing the liquid in the hydraulic support between these beams, which constitute alternately the platform and bed of the scale. The second part of the apparatus of the weighing mechanism comprises a system of levers and a scale-beam with suitable weights, and a pressure-column with its diaphragms, to which the pressure exerted in the testing-machine is transferred by a suitable tube. The liquid in the support between the beams, being compressed, is forced against the pressure-diaphragm of the pressure-column. The amount of force exerted here is then weighed, and the indication read from the scale-beam and the pointer which is atached to it. The reader should bear in mind carefully the distinction between the two pieces of apparatus. One is in and of itself essentially for testing. It gives no indications of the amount of strain applied, and is a perfectly independent and disconnected apparatus. The other is an indicating mechanism, and might be adjusted to a platform-scale, a weighing-lock, a track-scale, or, in fact, to a thousand and one other uses if necessary, its office being solely to register or indicate the amount of force exerted upon the system of levers which it contains. Although resembling to a certain extent the ordinary scale-beam, it differs not only in the nature of its connections, but also in the method of putting on and taking off its weights. This feature alone is entirely different from anything of which we have any account, and adds very materially to the ease and speed of weighing. One of the features which, not only in chemical but also in large balances, is inherent in Mr. Emery's system of weighing, is the fact that the motion of the load is so small, and the consequent momentum so insignificant, that the beam or pointer can come to rest quickly without a long series of vibrations on each side of the zero.

The construction of the apparatus will be better understood by a reference to Fig. 1, showing the base of the machine and framework, with portions broken away to show the more important features. Bearing in mind that whether the strains be those of tension or compression—that is, whether in an upward or downward direction—they must result in compressing the liquid in the pressure-support, the reader is prepared to understand the method of operation. The resistance, or the final abutment, is found in the frame, F, which is of cast-iron and very heavy. This frame surrounds the two beams, E E, which constitute the bed and platform of the scale, and between which is placed the hydraulic pressure-support. When the strain takes an upward direction these pieces are forced against the upper member of the frame. When the pressure is downward they rest on the lower portion of this frame. They have between them, in the pressure-support, a pair of diaphragms inclosing a quantity of fluid, which, by means of the slender tube, *f*, communicates with the pressure-column of the weighing apparatus. These pieces, E E, are surrounded by a yoke, B D C D, in which they are perfectly free and with which they have no rigid connection. The strain of the load is taken by this outside yoke entirely, and through it communicated to the abutment-pieces, E E. These two pieces, with the diaphragm between them and its inclosing rings, are finished to such a thickness that they just fill the space between the two members of the frame to within, say, $\frac{5}{1000}$ inch. This is the maximum amount of motion which is permitted. Having this arrangement of yoke and abutment-pieces, it becomes necessary to hold it in position and prevent it from any lateral motion, and at the same time allow it perfect freedom in a vertical direction. This is accomplished by a most ingenious modification of the flexible plate or metal fulcrums. For example, the upper beam, E, is held and supported in position and prevented from side motion by the thin bars, *b b*. The vertical motion is so small that the elasticity of these spring-bars, *b b*, allows it to rise and fall with practically no friction.

Similar flexible bars, *c c*, support and fix in position the lower scale-beam, E, against horizontal motion and allow freedom of motion vertically. The yoke is in like manner firmly fixed against horizontal motion at its top and bottom by four pairs of spring plates, two of which, *a a* and *a′ a′*, at the top, are attached at right angles to each other to the upper beam, A B, of the yoke and to the frame, F, while the other two pairs at the bottom, *e e* and *e′ e′*, also at right angles to each other, are fixed to the lower beam, C, of the yoke, and to the frame, F. They allow perfect freedom in a vertical direction, while compelling the whole movable portion to work in a vertical line. A beam, G, is bolted to the bottom, beam, C, of the yoke, and has its two ends extended between two pairs of initial load springs, marked *d d*. The yoke, B C D D, and its contained scale-beams, E E, being suspended in the air by the six pairs of fixing-springs, as before mentioned, is now carried firmly against the beams, E E, by the full pressure of the load-springs, *d d*, by means of two pairs of screws not here shown, one pair of screws acting to apply the load of these springs, *d d*, in an upward direction, and the other in a downward direction. When these springs are made to bear upward against G, the yoke is resting against the lower scale-beam, E, transmitting the load of the springs, *d d*, through the pressure-support to the upper beam, E, which now becomes the bed of the scale, with its outer ends resting against the frame, F, at the top, while the lower beam, E, acts as a free platform, and the scale is then balanced ready for use with strains of tension. If strains of compression or transverse loads are desired, the load-springs, *d d*, are made to act downward on the beam, G, the upper beam, E, now acting as the free platform, and the lower beam, E, as the bed of the scale. The acting area of the diaphragm in this apparatus, where a strain of 75 tons is to be exerted, is 13.6 inches in diameter.

The testing-machine is arranged for transverse strains by putting a heavy bar across the top of the table, A, which carries at its two ends suitable supports with hemispherical bearings on which the specimen rests. The outer ends of these bars are supported by braces, the lower ends of which enter the slot shown near the base of D in Fig. 1. Immediately under the ram is shown a gauge for reading the deflection. The cross-head which carries the hydraulic ram is arranged in a very neat but somewhat peculiar manner. It is carried by two screws, the nuts of which have, both above and below, a pair of gear-wheels. A pair of intermediate gears transmit the motion from one to the other, and the whole is moved up and down by means of a crank at the left hand of the machine. This crank, through a pair of bevel-gears, works the vertical shaft on the left-hand side with its two pinions, thus revolving the nuts. The shaft is provided with the usual slot and feather. This makes the matter of adjustment for different lengths of specimens comparatively easy, and, at the same time, simple. The cylinder is a double-acting one, and is connected with the force-pump by means of two telescopic tubes, shown at the right-hand side, and connecting with the cylinder itself by small bent copper pipes. These telescopic tubes are arranged in such a way that no changes in the connections are needed in any part of the stroke. For extension a peculiar form of jaw screws into the bottom of the piston-rod or ram, and also into a hole in the beam A B. The weighing mechanism itself consists of a weight-beam, somewhat similar to that shown in Fig. 5 in the article WEIGHING-MACHINE, with its indicator-rod and a series of suspension-rods for carrying weights. This beam in the scale shown is not connected directly to a pressure-column, but is moved by a large steel beam 2.5 inches deep by 10 inches in width, pivoted with plate fulcrums and moved by a pressure-column. Just above the block is the case containing the small pressure-chamber which is connected with that in the support between the scale-beams. The method by which weights are put on and taken off is in this case so entirely novel and different from anything that has been employed in ordinary weighing-machines that we give it in detail. Fig. 2, on a large scale, shows the weights with their rod. The rod D carries on its front side a number of lugs, and is supported by a plate from the beam, the suspension-spring being shown at the point marked D. The rods A and B also carry on their faces a number of lugs, and are supported by the cross-head, C, attached to one end of a rod which is operated by a lever below; *a, b, c, . . . k* are the weights. The problem is to successively throw these weights upon the beam. This is accomplished by a downward movement of the rods A and B. The lugs not being evenly spaced,

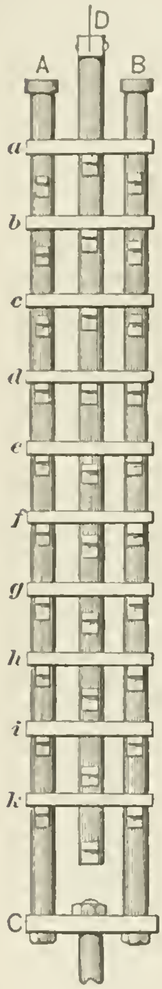


FIG. 2.

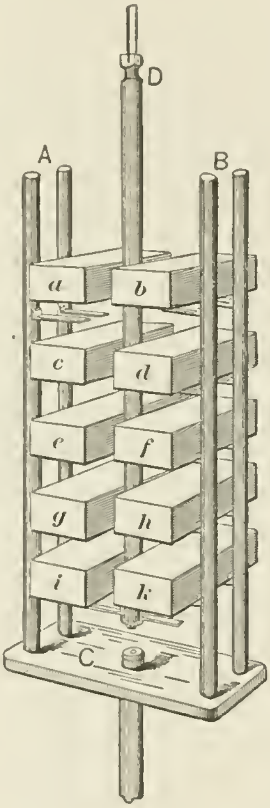


FIG. 3.

this downward motion brings the top weight, *a*, in contact with the uppermost lug on the rod D. If the motion is continued, *b* is next dropped on the rod, and *c* follows. In the engraving *a, b, c* have already been left by the downward motion of A B on the rod D. The weight *d* is bearing not only on the center, but also on the side rods, and any further downward motion of A B would allow it to rest upon D. The other weights would be in succession deposited on the central rod by a continuance of the downward motion. On the front of the beam there are three sets of these rods, each one of them carrying a carefully adjusted set of weights, 10 in number. When all of one set are upon the beam the next set is added, and so on, gradually increasing the weights until the limit of capacity is reached. The weights are arranged to add tens, hundreds, and thousands of pounds to the balancing-load. At the outward end of the beam, however, it is desirable to put on still greater weights, and Fig. 3 shows how these large weights are arranged. As in the previous case, there are 10 of them, but they are carried by two sets of rods fastened to the cross-head, C. The rod D has arms projecting from it. One pair of these arms is shown at its bottom just below the weights *i* and *k*. By the lowering of A B, the weight *a* is first picked up by the rod D, then *b* follows, and so on, until all are carried by D. When the cross-head, C, is raised the weights are lifted from D in a reverse order. In the front of the case which covers the beam four handles are seen. These handles, by motion up and down, move, by means of levers, the weight-frames, and put on or take off the weights. At the same time they raise or lower a series of pointers, and thus indicate just how many weights have been placed on the beam. In starting to weigh, all the handles are moved so as bring the pointers to zero. See *Testing-machines* and *Weighing-machine.*

EMINENCE.—A high or rising ground which overlooks and commands the low places about it. Such places within cannon-shot of any fortified place are a great disadvantage if the besiegers become masters of them.

EMIR.—An Arabic word, equivalent to "Ruler;" it is a title given in the East, and in the North of Africa, to all independent Chieftains, and also to all the actual or supposed descendants of Mohammed through his daughter Fatima. The latter are very numerous throughout the Turkish dominions; but although entitled by birth to be classed among the first four orders of society, they enjoy no particular privileges or consideration; on the contrary, they are found engaged in all sorts of occupations, and are to be met with among beggars, and the lowest of the populace, as frequently as among the Mollahs. Their privileges are confined to a few unimportant matters, chiefly to the exclusive right to wear turbans of a green color, that having been the favorite color of the Prophet. They are placed under the supervision of the Emir-Beshir. In former times the title of Emir was borne by the leaders in the religious wars of the Mohammedans, as well as by several ruling families, such as the Thaherides and Samanides in Persia, the Tulunides in Egypt, the first seven Ommaiades in Spain. The title Emir, in connection with other words, likewise designates different offices. *Emir-al-Mumenin*, "Prince of the Faithful," is the title assumed by the Caliphs themselves; *Emir-al-Muslemin*, signifying the same thing, was the title of the Almoravides. *Emir-al-Omrah*, "Prince of Princes," was the title of the first Minister, under the Caliphs and the East Indian Moguls, who united in his own person the highest civil and military dignities. It is now the title of the Governors of different Provinces. The Turkish Master of the Horse is styled *Emir-Achor;* the Standard-bearer, *Emir-Alem;* and the leader of the caravans of pilgrims to Mecca, *Emir-Hadji. Ameer* or *Amere* is another spelling of the same word.

EMISSARY.—A spy, a scout. In a military sense, one who during war-time personates the dress, language, and character of the power or nation he is sent amongst for the purpose of obtaining information, or for the purpose of creating disaffection in the ranks of the enemy.

EMOLUMENT.—The profit arising from office or employment; that which is received as a compensation for services, or which is annexed to the possession of office, as salary, fees, and perquisites. See *Pay.*

EMOUSSER.—To blunt, to dull. In a military sense, the word signifies, to take off the four corners of a battalion which has formed a square, and to give it, by those means, an octagonal figure; from the different obtuse angles of which it may fire in all directions.

EMPEROR.—The original signification of this, which in the modern world has become the highest title of sovereignty, can be understood only when it is taken in conjunction with *imperium*, which in the Roman political system had a peculiar and somewhat technical meaning. The imperium of a Magistrate, be he King or Consul, was the power which he possessed of bringing physical force into operation for the fulfillment of his behests. This power was conferred by a *Lex Curiata*, and it required this authorization to entitle a Consul to act as the Commander of an Army. In the case of the Kings also, the imperium was not implied in their election, but was conferred separately, by a separate act of the national will. "On the death of King Pompilius," says Cicero, "the *populus* in the *comitia curiata* elected Tullus Hostilius King, upon the rogation of an *interrex;* and the King, following the example of Pompilius, took the votes of the *populus*, according to their *curiæ, on the question of his imperium.*" Now, it was in virtue of this imperium that the title Imperator was given to its possessor. Far from being an Emperor in the modern sense, he might be a Consul or a Proconsul; and there were, in fact, many Imperators, even after the title had been assumed as a prenomen by Julius Cæsar. It was this assumption which gradually gave to the title its modern signification. In republican times it had followed the name, and indicated simply that its possessor was *an* Imperator, or one possessed of the imperium; now it preceded it, and signified that he who arrogated it to himself was *the* Emperor. In this form it appears on the coins of the successors of Julius. After the times of the Antonines the title grew into use as expressing the possessor of the sovereignty of the Roman world, in which sense *Princeps* also was frequently employed. In the introduction to the *Institutes*, Justinian uses both, in speaking of himself, in the same paragraph. From the Emperors of the West the title passed to Charlemagne, the founder of the German Empire. When the Carlovingian family expired in the German branch, the Imperial crown became elective, and continued to be so till it ceased—Francis II., who in 1804 had declared himself hereditary Emperor of Austria, having laid it down in 1806. In addition to the Emperor of Austria, there are now in Europe the Emperor of Russia and Emperor of Germany, the latter of whom was, on January 18, 1871, proclaimed under this title within the Hall of Mirrors, in the Palace of the French Kings at Versailles, in the presence of the German Princes, and the standards of the German army which was beleaguering Paris. In 1876 the Queen of England assumed the title of Empress of India, in addition to those which she bore previously.

EMPILEMENT.—The act of disposing shot and shell in the most secure and convenient manner. This is always done in arsenals and citadels.

EMPRISE.—A hazardous attempt upon the enemy. See *Enfans Perdus* and *Forlorn Hope*.

EMPTY BASTION.—When the rampart, following the outline of the crest of the bastion, has in its center an interior space on the level of the ground, the bastion is called *empty* or *hollow*.

ENCAMPMENT.—A lodgment or home for soldiers in the field. There are *intrenched* camps, where an army is intended to be kept some time, protected against the enemy; *flying* camps, for brief occupation; camps of *position*, bearing relation to the strategy of the Commander; and camps of *instruction*, to habituate the troops to the duties and fatigues of war. Under Camp has been given an account of the manner in which Roman camps were constructed. It is probable that the same general plan was adhered to until the invention of gunpowder. When cannon came to be used, however, a new arrangement of camp became necessary, to shield the army from long-range projectiles. Everything, indeed, relating to attack and defense, especially to the latter, is taken into account in chosing the locality of a camp. A healthy site, good water, security from floods, and plenty of fuel and forage, are the chief requisites in a good encampment. The British army, when in the field, usually encamps by brigades or divisions, roads and paths being arranged before the troops arrive. The infantry, cavalry, and artillery are so placed as to defend each other in the event of a sudden attack. There is a chain of guards all round the spot; and the park of artillery is placed behind the troops. The sutlers and servants are in the rear of the camp, but not beyond the limits of the rear-guard. The tents of the infantry are ranged in rows perpendicular to the front, each row containing the tents for one company. The circular tents, now much used, accommodate fifteen men each. The cavalry are in like manner encamped in rows; but each circular tent accommodates only twelve men. There are streets or roads between the rows of tents, of regulated width; and the officers' tents are at a given distance behind those of the men: the subalterns' tents being nearest to those of the companies to which they respectively belong. As a general rule, the line of the whole encampment is made to correspond as nearly as practicable with that in which the troops are intended to engage the enemy when fighting is renewed; to which end the tents of each battalion are not allowed to occupy a greater space in front than the battalion itself would cover when in order of battle. Under most circumstances, in modern warfare, an encampment is not defended by artificial constructions; the Commander seeks security for his troops in streams, marshes, difficult surface of country, and numerous advanced posts. Sometimes, however, more extensive defense-works are necessary; and then we have an example of an *intrenched* camp, which becomes a fortified inclosure. The chief uses of such a camp are, to secure an army while covering a siege, or, in winter quarters, to accommodate a Corps of Observation while the active army is engaged elsewhere; or to defend a position near a fortified place. Care is taken that the site is not commanded by neighboring hills. All villages are occupied, and all obstacles removed, within a distance of half a mile or a mile. The area of ground selected is large enough to contain the necessary store of arms, ammunition, food, fuel, forage, and water, and to enable the troops to maneuver. The junction of two rivers is often selected as a favorable spot. Various defense-works are constructed around or near the spot, such as continuous earthworks, redoubts, flèches, etc. The position held by the Allies outside Sebastopol, during the long intervals when the cannonading was suspended, had many of the characteristics of an intrenched camp. Camps of *instruction* may be either temporary or permanent. Of the former kind was the camp formed at Chobham in Surrey in 1853, merely for the summer months, to exercise certain regiments in evolutions. Another was formed at Shorncliffe in Kent in 1855, at first to receive troops of the Foreign Legion; but it has since been improved to the condition of a permanent camp. The great establishment at Aldershott has been, by an ungrudging outlay of public funds, improved in all particulars, and the small agricultural village of Aldershott has grown into an important commercial town, with railway-stations, hotels, market-houses, handsome shops, etc. A large permanent camp has also been established in Ireland, on a plain called the Curragh of Kildare, and there is a smaller one at Colchester. See *Camp*, *Castrametation*, and *Field-service*.

ENCEINTE.—The best mode of arranging the elements of a defense requires that the work should be so planned that every point exterior to the defenses within cannon-range should be thoroughly swept by their fire. Owing to the form and height of the parapet, its fire can take effect only at some distance beyond it. The enemy having reached the ditch will not be exposed to fire unless some arrangement has been made to sweep the ditch. Any place where he can find shelter, where the missiles of the defense pass so high above him as to inflict no injury, is called a *dead-angle* or *dead-space*. To remove this defect, the main work may be so arranged as to sweep by its fire every point exterior to it, or auxiliary works termed caponieres, scarp and counterscarp galleries, etc., may be used. In the former case parts of the work must be thrown forward towards the enemy and other portions retired. These advanced parts are called *faces;* the retired parts, *flanks;* and the parts connecting the flanks, *curtains*. The outline of such a plan must be angular. The angular points towards the enemy are called *salients*. The angle formed by two retired parts, a *re-entering* angle. The line bisecting a salient angle is called the *capital*. In firing over a parapet, a soldier usually aims directly to the front, so that the line of fire and the parapet make nearly a right angle with each other. There is then an angular space in front of the salient (equal to the supplement of the salient angle) which receives no protection by direct fire from it. This space is termed a *sector without fire*. The continuous line of fortification inclosing a position is called the enceinte, the *body of the place* or the *main inclosure*. The general outline of the enceinte may be *curvilinear*, or a *polygonal figure* of any character. Whatever system may be adopted for the enceinte, there are some conditions which it must satisfy to render it effective: 1. It should have a steep revetted scarp; unbroken on all sides except for the necessary openings for communications; thoroughly flanked throughout by cannon and small-arms; and of sufficient height to prevent all ordinary attempts at escalade. 2. The scarp should be so covered by earthen or other masks that it cannot be reached by the projectiles of an assailant from any position exterior to these masks. 3. The parapet and interior covered shelters should be proof against solid and hollow loaded projectiles. 4. The parapet should command all the site and outworks exterior to the enceinte and within range of its guns, and sweep them with flank and cross fires. 5. As far as practicable, the principal lines of the parapet should receive such directions that the assailant cannot take up positions to enfilade them. If the position thus inclosed be an inhabited one, as a city, town, etc., or an important point that requires the presence of other persons than those necessary for its defense, it receives the name of *fortress*, or *fortified place*. If it is destined to receive no other inhabitants but the troops for its defense, it is called a *fort;* and the defenders are termed the *garrison*.

ENCOMBRER.—In fortification, to fill up any hollow place, such as a stagnant lake, etc., with rubbish.

ENCOUNTER.—Literally, a combat or fight between two persons. It is not unfrequently used to describe a battle or attack by large or small bodies of troops.

ENDORSE.—In Heraldry, an ordinary containing the fourth part of a pale. *Endorsed*, again, or *indorsed*, signifies that objects are placed on the shield back to back. See *Heraldry*.

ENDURANCE OF GUNS.—The principal injuries caused by service are internal, arising from the separate action of the powder and the projectile. They increase in extent with the caliber, whatever may be the nature of the gun, but are modified by the material of which it is made. The injuries from the powder generally occur in rear of the projectile. They are: 1st. Enlargement of that portion of the bore which contains the powder, arising from the compression of the metal. This injury is more marked when a sabot or wad is placed between the powder and the projectile, and is greatest in a vertical direction. 2d. Cavities produced by the melting away of a portion of the metal by the heat of combustion of the charge. 3d. Cracks arising from the tearing asunder of the particles of the metal at the surface of the bore. At first a crack of this kind is scarcely perceptible, but it is increased by continued firing until it extends completely through the side of the piece. It generally commences at the junction of the chamber with the bore, as this portion is less supported than the others. 4th. Furrows or scoring produced by the erosive action of the inflamed gases. This injury is most apparent where the current of the gas is most rapid, or at the interior orifice of the vent, and on the surface of the bore, immediately over the seat of the projectile. *Scoring* commences very early in large guns; at first it is only a mere roughness, which gradually increases in depth and forms lines along the bore; but it is not until a gun has been fired very considerably that it becomes of importance. The impressions of deep scoring resemble the bark of an old elm-tree, the metal being eaten away into irregular furrows and ridges. Even when it has reached this extreme case, however, scoring has not caused the destruction of the gun, though in some instances, acting like a wedge, it has split the bore at that part. Some experimental guns, excessively scored on the upper side of the bore, have been turned over, vented and sighted on the under side; but this has not been found necessary until the gun has been used more than is probable under ordinary circumstances.

The injuries arising from the action of the projectile occur around the projectile and in front of it. They are: 1st. Indentation in the lower side of the bore, produced by the pressure on the projectile by the escape of gas through the windage, before the ball has moved from its seat. The elasticity of the metal, and the burr, or crowding up of the metal in front of the projectile, cause it to rebound, and, being carried forward by the force of the charge, to strike against the upper side of the bore, a short distance in front of the trunnions. From this it is reflected against the bottom, and again reflected against the top of the bore, and so on until it leaves the piece. The first is called "indentation," and the others are called "enlargements." In pieces of ordinary length there are generally three enlargements when this injury first makes its appearance, but their number is increased as the "indentation" is depressed and the angle of incidence increased. The effect of this bounding motion is alternately to raise and depress the piece in its trunnion-holes, and to diminish the accuracy of fire, until finally the piece becomes unfit for service. It is principally from this injury that bronze guns become unserviceable. Mortars and howitzers are not much affected by it. The principal means used to prevent this injury are to wrap the projectile with cloth or paper, and to shift the seat of the projectile. The latter may be done by a wad or lengthened sabot, or by reducing the diameter and increasing the length of the cartridge. The last of these methods is considered the more practical as well as the more effective; and it has the additional advantage of decreasing the strain on the bore, by increasing the space in which the charge expands before the ball is moved. 2d. Scratches or furrows made upon the surface of the bore by rough projectiles, or by case-shot. 3d. Cuts made by the fragments of projectiles which break in the bore. 4th. Wearing away of the lands of rifled cannon, especially at the driving-edges. A little rubbing of the side of the grooves from the friction of hard bearings is of little importance. 5th. Enlargement of the muzzle, arising from the forcing outward of the metal by the striking of the projectile against the side of the bore as it leaves the piece. By this action the shape of the muzzle is elongated in a vertical direction. 6th. Cracks on the exterior. These are formed by the compression of the metal within, generally at the *chase*, where the metal is thinnest. This portion of a bronze gun is the first to give way by long firing, whereas cast-iron guns usually burst in rear of the trunnions, and the fracture passes through the vent, if it be much enlarged.

The endurance of a smooth-bore gun with service-charges may be surely predicted by observation of the progressive wear of the interior orifice of the vent. There are certain general forms in which this enlargement takes place. They may be classed as triangular, lozenge, quadrilateral, star, circular, and elliptic. With the lateral vent of the Dahlgren system it usually takes the lozenge form, the cracks extending from the opposite angles lengthwise of the bore. With those rifled cannon in which the vent is bouched, the cracks appear around the bouching, and although the bouching preserves the vent, yet the formation of fissures around the enlarged orifice, when once commenced, causes a greater tendency to rupture. With the vent not bouched, the wear in rifled cannon is about double that of the smooth-bore. So long as the wear of the vent is regular and without cracks, a mere enlargement is not indicative of danger; but when it reaches a diameter of four tenths of an inch, the vent should be closed and a new one opened. A gun of large caliber should not in service be expected to stand more than 400 or 500 rounds before it will be necessary to open the new vent, which, however, will be of no advantage unless the old one be closed at its interior orifice, on which the gases otherwise would continue to act as a wedge. The first distinct appearance of the cracks, as shown by the button, is the proper limit. After the gun bursts, a sketch or draught is made showing the lines of fracture, and specimens are reserved for trial of density and tensile strength; and, if practicable, a photograph is taken. See *Cannon* and *Ordnance*.

ENEMY.—An enemy, according to the civil law, is one who has publicly declared war against us, or we against him; all others are thieves or robbers. *Hostes hi sunt qui nobis, aut quibus nos, publice bellum decrevimus; cæteri latrones aut prædones sunt.* Thus, in order to constitute an enemy, there must be a public declaration of war. This declaration must also be made by a duly organized State or Kingdom, for a declaration of war by any turbulent body of men is not sufficient; and a hostile act committed by private citizens will not justify a war, unless that act be sanctioned by the Government. The purpose for which this public declaration is required is stated by Grotius to be that it may be clearly known that the war is undertaken not as a venture, but by the will of the two people. Hostilities having been formally declared, every subject of the hostile nations becomes an enemy of the opposing State, as do likewise those independent nations which attach themselves to the interests of either party. According to ancient usage, the utmost violence and cruelty was lawful towards those who were enemies of the State; but by the humane principles which prevail in modern times, warfare is to be carried on subject to certain general rules, which are intended as much as may be to lessen the calamities of war, and to protect the rights of individuals. Thus, an army invading an enemy's country is bound to suffer, as far as possible, the peaceable inhabitants to remain unmolested. Unnecessary devastation of the country and the seizure of property are also contrary to the laws of civilized war; and Grotius lays it down that the use of poisoned weapons, and of assassination, and violence to women, are to be reprobated. On the other hand, individuals taking up arms, without the sanction of the State, in order to annoy an invading enemy, are regarded as lawless marauders. The result of this distinction is that such persons are not treated as prisoners of war, but are subject to be summarily dealt with by the Commander of the Invading Army. It appears to be a recognized principle of international law that the property of an alien enemy residing in either of the hostile States may be confiscated. The Americans, during the war with England, asserted this right in regard to British property found in their territory. But the usage of civilized nations for a long period has much modified the stern rule of law. It is provided by Magna Charta, Cap. 30, that if merchants "be of a land making war with us, and be found in our realm at the beginning of the wars, they shall be attached without any harm of body or goods, until it be known to us, or our Chief-Justice, how our merchants be intreated there in the land making war against us; and if our merchants be well intreated there, theirs shall be likewise with us." Merchants of a Foreign State at war with England were allowed forty days, after proclamation of hostilities, wherein to remove from the Kingdom themselves and their goods; and if that space of time were not sufficient, forty days more were to be conceded to them. Vattel denies that the right to confiscate the goods of an alien enemy is a right inherent in a State by the law of nations, insisting that a Sovereign having permitted foreigners to enter the State, and to continue there, had tacitly promised them full liberty and security for their return. Whatever be the principle, there is no doubt that the almost universal practice of modern nations has been to respect the property of individuals at the outbreak of hostilities. Provisions are frequently inserted into commercial treaties stipulating that, in case of war, the subjects of the enemy shall have time to depart, and even that they should be allowed to remain and carry on a peaceable trade. The right to confiscate the debts of the subjects of a hostile nation appears to rest on the same basis as that of the confiscation of other property. Trade between the subjects of two hostile powers is absolutely suspended during hostilities, unless permitted by express sanction; and the importation of articles particularly useful in war is contraband. All such articles, whether supplied by the subjects of the enemy or of another State, are seized and confiscated. See *Contraband of War*, *Prisoners of War*, and *Prize*.

ENERGY.—When a projectile is in motion it is said to have energy, i.e., it is capable of doing work or overcoming resistance. The amount of energy is measured by the *product of the weight of the projectile into the height due to its velocity*, and is expressed in the same units as those of work done. Thus, if W be the weight of the projectile in pounds, h the height it would acquire in vacuo to attain a velocity v in feet per second, then the energy of the projectile is $Wh = \frac{Wv^2}{2g}$ foot-pounds, where $h = \frac{v^2}{2g}$. If V be the muzzle-velocity of the projectile, its energy at the muzzle of the gun is $\frac{WV^2}{2g}$; and since the energy of the projectile is equivalent to the work done on it, $E = \frac{WV^2}{2g}$, where E represents the energy at the muzzle. It will therefore be seen that the energy of the projectile at the *muzzle* is equal to the work done by the pressure of the powder-gas in the bore of the gun. See *Work*. In order to estimate the comparative power of guns for piercing iron plates, it is usual to express the energy of a projectile in terms of the number of inches in its circumference. Thus, energy per inch of circumference $= \frac{Wv^2}{4480g \times \pi d}$ foot-tons, where d is the diameter of the projectile in inches. Also, energy per inch of circumference at muzzle $= \frac{E}{\pi d} = \frac{WV^2}{4480g \times \pi}$; thus, muzzle-energy per inch of circumference of 10-inch Palliser shell

$$= \frac{5160}{3.1416 \times 9.92} = 165.6 \text{ foot-tons.}$$

In addition to this energy (due to the velocity of translation), there is energy due to the velocity of rotation. This, however, being small as compared to that due to translation, is usually neglected. See *Projectiles*.

ENERGY OF RECOIL.—An expression for the work done in the recoil of a gun when fired. It may be reduced by decreasing the weight of the projectile, by decreasing the muzzle-velocity, or by increasing the weight of the gun and carriage.

ENERGY OF ROTATION.—The power of a rotating body to preserve its axis in the original direction depends upon its *energy of rotation*, or $\frac{W(k\alpha)^2}{2g}$, where W is the weight, k is the radius of gyration, and α is the angular velocity. We thus see that a shell possesses more "energy" than a shot of the same weight rotating at the same speed,—since its radius of gyration is greater.

It will be found that the initial velocity of rotation depends directly on the muzzle-velocity of translation; but the two do not decrease together in flight, the rotation being very slightly decreased even at long range, as has been found by noting scorings on graze.

ENFANS PERDUS.—Forlorn hope; in military history, the soldiers detached from several regiments, or otherwise appointed, to give the first onset in battle, or in an attack upon the counterscarp, or the breach of a place besieged; so called (by the French) because of the imminent danger to which they are exposed.

ENFIELD BREECH-LOADING REVOLVER.—This revolver differs from the patterns usually met with in having a rebounding lock, and in its method of extracting the empty cartridge-cases. The principal parts are the barrel, the cylinder, and the body. The barrel is 5¾ inches in length, and the diameter of bore and the form and twist of the rifling are the same as in the rifle. The barrel is attached to the body by means of a screw passing through a knuckle-joint in an arm which projects below the breech-end. It is held in the firing position by a spring-catch in front of the hammer. The "axis-pin" of the cylinder is screwed into the body, its point resting in a recess in the joint-arm of the barrel. A projection or boss on the cylinder engages in the same recess. By this arrangement, when the catch holding the top bar is released and the barrel depressed, the cylinder is drawn along its axis, and the bases of the cartridges in the chambers being held by a radial extractor, which is free to move only a short distance along the "axis-pin," the cartridge cases are drawn from the chambers to such a distance that those which are empty are free to fall away, while filled cartridges are held by the bullets remaining in the chambers. The cylinder contains six chambers, and the pistol is loaded in the ordinary way. The lock consists of seven components, viz.: hammer, axis-screw, trigger, trigger axis-screw, pawl, lever, and main-spring. The main-spring governs the movement of each component. The act of pulling the trigger cocks the pistol and fires it, and upon the release of the trigger the hammer rebounds to half-cock. The stock is of walnut, and the remaining parts are of steel. The system of manufacture is similar to that of the rifle. Weight of pistol, 2 lbs. 8¼ oz. See *Royal Small-arms.*

ENFIELD RIFLE.—This arm was at one time in use in the British army. It takes its name from the small-arm factory at Enfield, a Government establishment for the manufacture and supply of small-arms of every description to the army. It was originally a muzzle-loading arm, but was subsequently converted into a breech-loader; it is now known as the Snider-Enfield. There are two patterns, that of 1853 having 3 grooves, and that of 1860, 5 grooves. The length of the barrel of the pattern musket of 1853 is 54 inches without the bayonet; having one spiral turn in 78 inches. Weight with bayonet, 9 lbs. 12 oz. The short rifle-musket pattern (1860) is 48¾ inches in length without the bayonet, having one spiral turn in 78 inches. Weight with bayonet, 10 lbs. 4¼ oz. Some of the native regiments in India are armed with the Enfield rifle, and some with the Snider-Enfield.

ENFIELD SIGHT.—With the exception of the Prussian infantry sight, the rear sights of nearly all the modern European small-arms are similar in construction to that of the English Enfield rifle-musket. The only exception seems to be the Swiss sight, which operates on the general principle of the gunner's quadrant. The common features of the Enfield class of rear sights are the long base, which is attached in various ways to the barrel, the leaf with its slides, and the strong flat spring attached to the base to keep the leaf in position, either standing up or lying down.

A peculiar feature of this class of sights is that the elevations corresponding to the shorter ranges are obtained by resting the leaf in certain offsets made in the projecting sides of the base. Great attention has been paid in England toward improving the sight of the Martini-Henry rifle. The sight-notch for short distances is made very open. The slide for long distances has a very faint notch in the middle, and two white lines, one on each side of the central notch, and about a tenth of an inch from it. The object of these lines is to assist the marksman in making allowance for drift and wind. See *Brown Sight.*

The following table gives the length of the stock and position of the rear sight for the principal European guns. These dimensions are considered to have an important effect on the recoil of the gun and the accuracy with which it can be aimed:

Name of Gun.	Distance from center of butt-plate to trigger.	Distance from center of butt-plate to line of rear sight.
	Inches.	*Inches.*
Martini-Henry (British)	14 and 14½	25
Chassepot (French)	13½	21½
Werder (Bavarian)	13½	23½
Mauser (Prussian)	13½	22
Vetterlin (Swiss)	12	21½
Russian (Berdan)	14	21
Werndl (Austrian)	13	22
Comblain (Belgian)	13½	22

ENFILADE.—A military term applied to a fire of musketry or artillery made in the direction of the length of a line of troops or a line of rampart. A besieging battery so placed as to send its shot along any part of the line of a fortification, and inside the parapet, does great execution in dismounting the guns, which thus present the largest surface to the balls. Hence the lines of ramparts should be planned that their prolongations may fall in situations inaccessible to the enemy. Where this is not possible, the lines are either broken, or are protected by bonnets, or by traverses or blindages. In the siege of a fortress the trenches of approach are cut in a zigzag to prevent the defenders enfilading them from the walls.

ENFILADING BATTERY.—Enfilading and counter batteries are used for destroying the artillery and traverses, and silencing the fire of the defenses. Positions are chosen for the enfilading-batteries from which the terre-pleins of the faces, and other lines that bear upon the ground on which the parallels and approaches are laid out, can be swept throughout; the counter batteries are so placed that they can bring a direct or a slant fire against the embrasures of the points to be silenced. The shot from the former is thrown with small charges, under small angles of elevation, so as to ricochet along the terre-pleins, taking the guns of the defenses in flank; the latter fire with full charges directly against the point to be attained. As the effects of both direct and enfilading fire vary greatly with the range, positions should be chosen for these batteries as near the defenses as they can be thrown up without too great a sacrifice of life. Positions which will give ranges between 300 and 700 yards are the best for smooth-bore guns; nearer than 300 yards the workmen would be exposed both to the fire of musketry and case-shot; beyond 700 yards the fire upon the defenses becomes very uncertain.

The greater range of rifled guns gives to the besiegers a greatly enlarged zone in the choice of positions for enfilading and counter batteries over that for the ordinary siege-train of smooth-bore guns. This greater range and the greater certainty of the fire of rifled guns are more favorable to counter-batteries than to those intended for enfilading; as the great angles of elevation under which the guns are fired, to attain the desired ranges, give to the projectile, in the descending branch of its trajectory, a great plunge, which, although more favorable to attaining objects covered by traverses than if the plunge were smaller, is less favorable to the ricochet of the projectile from which the chief advantage of enfilading with round shot is derived. Besides this, the elongated projectiles used in rifled guns from the form given to their point are readily deflected from their course by very slight obstacles, as a fascine even, which also adds to the uncertainty of their effects. At the siege of Fort Wagner it was observed that the heavy projectiles of the smooth-bore navy guns were landed with more accuracy within the enemy's works, and were more destructive in their ricochet, than the projectiles from the army rifled guns.

The judgment and experience of the officer must in these cases be left full play in the selection of the position of the batteries of these two classes of guns and in their armament; bearing always in mind two very important considerations: first, that with long ranges and high angles of elevation the projectiles will clear all the trenches in front up to a near approach of the besieged work without danger to them, except from unforeseen accidents; and second, that to secure any decided or certain effect from either class of these batteries there must be nothing to obstruct the view of the object to be attained. The batteries may be placed either within the parallels, in advance of, or in rear of them. The positions usually selected are from 20 to 30 yards in front of the parallels; because, if placed within them, there might be mutual interference between the service of the batteries and that of the parallels, which is often a very serious cause of delay to both the service of the batteries and the passage of troops; and, unless placed some distance in the rear of it, the parapet of the parallel might obstruct the shot of the battery, and the troops in the trench be annoyed by the fire.

The most effective positions for batteries of smooth-bore guns are in front of the second parallel of from 300 to 400 yards from the point to be reached; and unless the fire of the defenses is very destructive, it will be best to place them there. If placed in front of the first parallel it may be necessary to shift the most of them to the front of the second parallel soon after the latter is thrown up; for the third parallel and the approaches leading to it from the second parallel run the risk of being attained by shot from batteries at so great a distance in their rear as the first parallel. See *Batteries* and *Counter-battery*.

ENGAGE.—A movement in fencing and bayonet-exercise executed as follows: Being in the position of the *guard*, the Instructor commands: 1. *Engage*, 2. TIERCE. At the command *tierce*, numbers one and two cross their bayonets, about 6 inches from the points, the bayonets touching on the right. Engage in *quarte* is similarly executed, the bayonets touching on the left. Each man seeks to cover himself on the side engaged, so as not to be reached by a direct lunge from his adversary.

Being engaged in *tierce*, if number two be too quick to be reached by disengaging, the Instructor commands: ONE, TWO, LUNGE. At the command *one*, number one passes his bayonet quickly under the bayonet of number two, from *tierce* to *quarte;* at the command *two*, he returns quickly from *quarte* to *tierce;* and at the third command, lunges as explained for the *lunge in tierce*. At the command *one*, number two executes *quarte*, *prime*, or *butt parry;* and at the command *two*, executes the *tierce* or *seconde parry*, and then thrusts or lunges at command. If engaged in *quarte*, the feint from *quarte* to *tierce*, the return to *quarte*, and the *lunge* are executed by the same commands, the lunge being in *quarte*. At the command *one*, number two parries in *tierce* or *seconde;* at the command *two*, he executes the *quarte*, *prime*, or *butt parry*, and then thrusts or lunges. Number two is taught the feints in the same manner, and number one executes the double parries. See *Bayonet-exercise*, *Disengage*, and *Fencing*.

ENGAGEMENT.—A military engagement considered as a conflict between two armies or hostile forces cannot be described within limits suitable for this work. Almost every term applicable to armies in the field bears relation, in some way or other, to a hostile engagement, and those terms will be found briefly noticed under their proper headings. A naval engagement admits of more precise and terse illustration than a military engagement, because each ship of war is a unit in itself, bounded by a clearly marked watery margin from all the other ships of a fleet. See *Battle*.

ENGINEER BATTALION.—A component part of the Corps of Engineers, consisting of five companies of Engineers, one Sergeant Major, and one Quartermaster Sergeant, who is also Commissary Sergeant. Each company of Engineer soldiers consists of ten Sergeants, ten Corporals, two Musicians, and as many Privates of the first class, not exceeding sixty-four, and as many Privates of the second class, not exceeding sixty-four, as the President may direct, and is recruited in the same manner, and with the same limitation, and is entitled to the same provisions, allowances, and benefits, in every respect, as are allowed to other troops constituting the present military peace establishment. A Battalion Adjutant, a Battalion Quartermaster, and appropriate officers to command the companies and Battalion of Engineer soldiers, are detailed from the Corps of Engineers. The enlisted men of the Engineer Battalion are instructed in and perform the duties of sappers, miners, and pontoniers, and aid in giving practical instruction in those branches at the Military Academy. They may be detailed by the Chief of Engineers to oversee and aid laborers upon fortifications and other works in charge of the Engineer Corps, and, as fort-keepers, to protect and repair finished fortifications. See *Corps of Engineers*.

ENGINEER COLORS.—In the United States army the national color, as described for the garrison-flag, with the words "U. S. Engineers" embroidered in silver on the center stripe. The battalion color is of scarlet, of the same dimensions as above, bearing in the center a castle, with the letters U. S. above and the word Engineers below, in silver; fringe white. The size of each color, and the length of pike, are the same as described for artillery and infantry colors. Cords and tassels are formed of red and white silk intermixed. See *Colors*.

ENGINEER CORPS.—In modern nations the necessity for a Corps of Staff-officers, trained to arrange for and overcome the embarrassments of the movements of an army in the field, has been thoroughly demonstrated, and hence in most European armies a trained Staff of Officers is organized for this purpose. In the United States a force of about three hundred officers and enlisted men are engaged in these duties. See *Corps of Engineers*, *Engineer Battalion*, and *Royal Corps of Engineers*.

ENGINEERING.—Engineering, the business of the Engineer, is the art of designing and superintending the execution of works of a constructive character, such as roads, railways, bridges, canals, harbors, docks, works for supplying water to towns, drainage and sewerage works, mining machinery, and the working of metals. It may be divided into two kinds—Civil and Military. The Military Engineer is an officer in the service of Government, whose duties are principally to construct fortifications, to make surveys for warlike purposes, to facilitate the passage of an army by the construction of roads and bridges; in short, to execute all engineering works of a military nature; but he is also, especially in this country, called upon to undertake many works which more properly belong to the business of the Civil Engineer, such as the survey of the country, the inspection of public works, and, in short, all the duties of a Government Engineer. The Civil Engineering profession is subdivided into several sections according to the special nature of the employment of its members. The Railway Engineer projects and superintends the execution of railways and all the works in connection with them, such as the alteration of roads and streams, the construction of viaducts, bridges, cuttings, and embankments. The Hydraulic Engineer constructs the works connected with the supply of water to towns, the filtering of water, its collection in reservoirs, and its distribution through a town or district; the irrigation and drainage of tracts of country; the protection of low lands from inundation, and the use of water as a motive power. The Dock and Harbor Engineer has the management of all works connected with the sea or navigable waters, such as the construction of piers, breakwaters, docks, harbors, and light-houses. The Mechanical Engineer is principally concerned in the manufacture of machinery, the working of metals, the construction of ships, steamers, cannon, and all the various structures in which the metals bear a prominent part. Then there is the Mining Engineer, who discovers minerals and manages mines; there are Engineers who are specially engaged in the drainage of towns, and many other less prominent divisions of the profession.

The engineering works of antiquity are both numerous and prominent, many of them remaining while all other traces of their constructors have been swept away. The most notable of the works belonging to very remote antiquity are the harbors of the Phœnicians, the palaces and sewerage of Nimroud, and the pyramids of Egypt; next in order come the harbors of ancient Greece, the bridge of boats across the Dardanelles, made by Xerxes to transport his immense army into Europe, and his canal across the isthmus of the peninsula of Mount Athos. The buildings of ancient Rome next claim attention—its theaters, temples, baths, and its aqueducts, some of which carried water from distances of more than fifty miles into Rome; its roads, bridges, and drainage-works vie in extent and magnificence with the most celebrated works of modern times. From that period down to the commencement of the eighteenth century the most extensive works executed are the canals, embankments, and other hydraulic constructions used by the Dutch for the purposes of inland navigation, and to protect their low lands from the sea; the canals of North Italy, the cathedrals and fortifications of mediæval Europe. Civil Engineering, as a distinct *profession*, may be said to have originated in England about the middle of the last century; since that time the improvements in the steam-engine by James Watt, its subsequent application to the railway system by George Stephenson, and its use in navigation, have given a great impulse to commerce and civilization; which in their turn have created the necessity for the numerous and magnificent engineering works of modern times, such as the innumerable railways, roads, and canals that intersect this and foreign countries; the bridges, water-works, docks, harbors, and vessels that facilitate our commerce and increase our comfort and prosperity. Among the most remarkable of these works may be mentioned the tubular bridges of the St. Lawrence and Menai Strait, the Niagara Railway Suspension Bridge, the New York and Brooklyn Suspension Bridge, and the electric telegraph system, which covers this country and the seas and countries of Europe, and may at some future time connect us with the continents of Australia and India. The education of those who would rise to eminence in the profession must embrace a fair knowledge of pure mathematics and of the mixed sciences of natural philosophy, such as mechanics, hydrostatics, hydraulics, and optics. They should acquire a knowledge of the principles of projections, and should aim at being good draughtsmen and rapid and accurate arithmeticians. In conclusion, it may be said that every day opens fresh fields of Engineering Science and labor; and that as the first beginnings of the art are lost in the obscurity of remote antiquity, so we see no termination to its usefulness and necessity.

ENGINEERS.—The introduction of modern weapons has caused the development of tactics to take a peculiar direction, and has produced changes in the action of the various arms of the service, but nowhere are the changes more marked than in the art of the Engineer.

Looking at the subject generally, we find that one of the first consequences of the development of fire-arms at the end of the sixteenth and beginning of the seventeenth centuries was a large increase of the offensive power of arms, a reduction of defensive armor; and following from this a large increase of field-works. A history of war at this period would be the history of intrenchments, one army seizing a position, intrenching and holding it, the other watching it and afraid to attack.

The increase in roads, the opening up of the country, and the greatly increased size of armies under Napoleon, united to his peculiar strategy, the suddenness of action with which he sought to overcome an enemy, and the great development which the offensive received, all tended to the disuse of field-works and intrenchments. Although the rapidity of Napoleon's marches tended to develop other branches of the Engineer's art, that of bridging and that of the pioneer, to a far greater extent than had previously been known, yet Napoleon was clearly alive to the evils produced by the neglect of field-works. The history of this century shows that field-fortification, when it has been judiciously used, has invariably produced the greatest results, and these results were produced by the application of the same ideas, viz., the use of field-works to cover the front of a large extended position, one considerably larger than the troops could hold in line of battle, the flanks being protected and the communications for supplies being open to the rear. The celebrated lines of Torres Vedras are an instance of this. The English army, with its flanks resting on the Tagus and the sea, occupied with about fifty thousand men a line of some twenty-five miles in length; it had its internal communications perfectly open, its supplies were brought up by the sea, and the French General could do nothing; he was unable to outflank the lines, turn or attack them. They were so strong that any attack in front would have failed; the defenders could not be starved out, and unless they were regularly attacked by siege-works there was no means of dealing with them. From these lines the tide of conquest of the French armies first began to recede. Many years later the same thing happened at Sebastopol. The Russians, holding a long straight line of weak field-works with their communications open, actually advanced from their works, threw up fresh trenches and works, and almost besieged the Allies in their positions. Both these cases were brilliant examples of what field-works properly adapted to tactics can produce. There were great opportunities in the blockades of Paris and Metz for the tactics displayed by the Russians to be repeated; and it is no exaggeration to say that had the garrison of Paris been composed of good troops it might really have dug itself out of Paris and through the German lines.

It appears that at the present day the necessity of making flank attacks has given a fresh importance to field-works. When speaking of this subject previously, the ease with which an army having its flank threatened can change front and attack was pointed out, and it was further pointed out that to prevent such a change of front an attack in front as well as on the flank was needed. Now, is it not possible to check any attempted change of front by the construction of field works? The Americans in the Civil War made a very extensive use of intrenchments for this purpose; they covered their front, and then moved round to a flank. As soon as it was definitely learned with what severe losses front attacks, even when successful, must be uniformly accompanied, and as soon as the true value of temporary field-works on the field of battle was perceived, the further military history of the Civil War is but a narrative of maneuvers whose object was to gain the flanks of the enemy's position, and force him to abandon it by threatening his communications. The system of temporary works on the field of battle was carried to a greater extent during our Civil War than during any war before or since. The troops on each side soon learned to cover themselves at every opportunity, and this was the first duty performed when a halt for any length of time was made by armies in actual contact; in fact, on many occasions breast-works were constructed to cover the army as it advanced. The whole spirit of modern war is to reduce everything to calculation, to leave nothing to chance, to provide for and foresee all possible combinations, whether arising from moral causes, such as panics amongst the men, or from actual physical causes, such as the enemy's fire, or the configuration of the ground; whatever then increases the security of certain places or their defensive power is of the highest importance.

The duties of the Engineers in the field may be divided into two classes: 1. The duties of making, repairing, or destroying communications, including, in the word communication, roads, bridges, railways, and telegraphs. These may be classed together as pioneer duties. 2. The preparation of positions for attack or defense, which is the higher duty of the Military Engineer, and where the art of fortification must be considered entirely in a tactical point of view. With reference to the first class of duties, the men and means must be invariably present when required. The Engineers should march with the advanced-guard, and must be sufficiently supplied with tools and materials. It is the second class of duties, or those of the *Military Engineer* as distinguished from the *Pioneer*, where the tactical relation of field-works to the other arms is fully developed. The mere fact of field-works being constructed is far too often considered as limiting the action of the troops to a strict defensive; viewed in such a light, intrenchments are useless, if not hurtful, and hence arises the absolute necessity of viewing all such works in their tactical relation to troops. In almost every case in war six or seven hours may be calculated on to put a position in a state of defense, and if the Engineers and tools are where they should be, this period is ample: in six hours works of a very powerful nature may be constructed which will effectually support an army. It is generally allowed that an intrenchment occupied by two hundred men offers as much resistance as a battalion not so covered, and that the labor of one thousand men six hours on the position occupied by a division is equivalent to the reinforcement of a brigade. The pioneer duties of the Prussian army were admirably performed, and the true spirit of field-engineering was in many cases seized; one remarkable instance was at Mars-la-Tour. Early in the day the Prussians gained possession of Vionville, on the Verdun Road; the instant the infantry got in, two companies of Engineers supplied with six wagons of tools were pushed on; they were charged by a regiment of French Hussars and lost some of the wagons and a section of one of the companies, but the remainder got into the village, and so strengthened it that all the attempts to retake it failed. And although at the close of the day the Prussian right and left wings were forced back by the French, yet the village of Vionville, forming the apex of the Prussian position, was never lost, and effectually barred the road to Verdun. Here fortification was used correctly; it confirmed and established the success of the infantry, and secured the object for which the Prussians struggled so hard. See *Engineering*.

ENGINEER'S TRANSIT.—A portable instrument of the theodolite kind, designed for measuring both horizontal and vertical angles. The essential parts of the instrument, as shown in Fig. 5, are the *telescope* including its axis and two supports, the *circular plates* with their attachments, the *sockets* upon which the plates revolve, the *leveling-head*, and the *tripod* on which the whole instrument stands.

The *telescope* is from ten to eleven inches long, firmly secured to an axis having its bearings nicely fitted in the standards, and thus enabling the telescope to be moved in either direction, or turned completely around if desired. The different parts of the telescope are shown in Fig. 1. The object-glass, composed of two lenses, so as to show objects without color or distortion, is placed at the end of a slide having two bearings, one at the end of the outer tube, the other in the ring C C suspended within the tube by four screws, only two of which are shown in the cut. The object-glass is carried out or in by a pinion working in a rack attached to the slide, and thus adjusted to objects either near or remote as desired. The eye-piece is made up of four plano-convex lenses, which, beginning at the eye-end, are called respectively the eye, the field, the amplifying, and the object lenses, the whole forming a compound microscope having its focus in the plane of the cross-wire ring B B. Sometimes, especially in English instruments, an eye-piece of two lenses is employed; but this, while it gives more light, inverts the object seen, and so has been discarded by American engineers.

Where it is desired to take greater vertical angles than is possible with the ordinary eye-piece, the little cap on the end of the eye-piece is unscrewed and replaced by one containing a small prism, as shown in Fig. 2, which reflects the image of the object at right angles, and brings it to the eye of an observer from above; when used on the sun, a colored glass or darkener is interposed between the eye and prism. This arrangement consists merely of a diagonal prism attached to the cap of the eye-piece, by which the object is reflected to the eye, placed at right angles to the telescope; when directed to the sun, the little slide or darkener containing colored glass is moved over the opening. The circular plate with which the prism is connected is made to turn in the cap so that when it is substituted for the ordinary cap of the eye-piece, the opening over the prism can be easily adjusted to the position of the eye.

The object-glass receiving the rays of the light which proceed from all the points of a visible object, converges them to a focus at the cross-wires, and there forms a minute, inverted, and very bright image, which may be seen by placing a piece of ground glass to receive it at that point. The eye-piece acting as a compound microscope magnifies this image, restores it to its natural position, and conveys it to the eye. The visual angle which the image there subtends is as many times greater than that which would be formed without the use of the telescope as the number which expresses its magnifying power. Thus, a telescope which magnifies twenty times increases the visual angle just as much, and therefore diminishes the apparent distance of the object twenty times; or in other words, it will show an object two hundred feet distant with the same distinctness as if it were distant only ten feet from the naked eye.

It might be supposed that the greater the power of

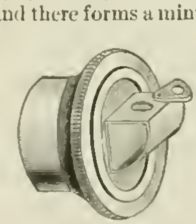


FIG. 2.

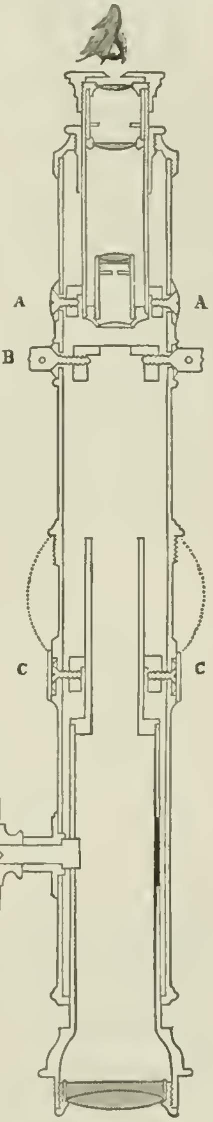


FIG. 1.

a telescope, the better; but in practice, beyond a certain point, this is found to be incorrect. In the first place, as only a given amount of light can enter the object-glass, the more the object is magnified the less clear and bright will it appear; and again, the higher the power the more difficult will it be to precisely focus the telescope and to complete its adjustment. We have found that a power of from twenty to twenty-four diameters in the telescopes of transits gives the best results and is amply sufficient for all ordinary practice.

The Kellner eye piece, the main feature of which is the use of a compound amplifying-lens, as shown in Fig. 1, in place of the single one heretofore employed, has sensibly increased the brilliancy of the object and secured a better field. This is now applied to all transit-telescopes. The eye-piece is brought to its proper focus usually by twisting its milled end, the spiral movement within carrying the eye-tube out or in as desired; sometimes a pinion, like that which focuses the object-glass, is employed for the same purpose.

The cross-wires, shown in Fig. 3, are two fibers of spider-web or very fine platinum wire, cemented into the cuts on the surface of a metal ring, at right angles to each other, so as to divide the open space in the center into quadrants. To remove the cross-wire ring, take out the eye-piece tube, together with the little ring by which it is centered, and having removed two opposite cross-wire screws, with the others turn the ring until one of the screw-holes is brought into view from the open end of the telescope-tube; in this thrust a pointed splinter of wood or a small wire, so as to hold the ring when the remaining screws are withdrawn; the ring is then taken out. It may be replaced by returning it to its position in the tube, and either pair of screws being inserted, the splinter or wire is removed, and the ring is turned until the other screws can be replaced. Care must also be taken that the same side of the ring is turned to the eye-piece as before it was removed. When this has been done, the eye-tube is inserted, and its centering ring brought into such a position that the screws in it can be replaced, and then by screwing on the end of the telescope the little cover into which the eye-tube is fixed the operation will be completed.

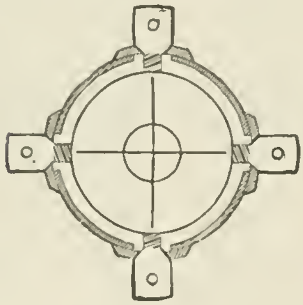


Fig. 3.

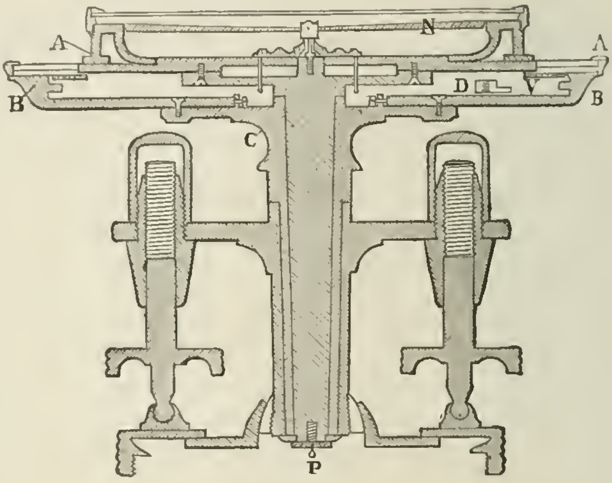


Fig. 4.

The advantage of platinum for the cross-wires of telescopes has long been conceded, but the difficulty of procuring it of sufficient fineness has prevented its general adoption. Platinum wires are now drawn of a fineness of from one eight-thousandth to one twelve-thousandth of an inch, and are used in the telescopes of all the best instruments, unless spider-lines are specially desired. These wires are perfectly opaque, and of course entirely unaffected by moisture, and are universally preferred to the spider-web heretofore used.

The intersection of the wires forms a very minute point, which, when they are adjusted, determines the optical axis of the telescope, and enables the surveyor to fix it upon an object with the greatest precision. The imaginary line passing through the optical axis of the telescope is termed the "line of collimation," and the operation of bringing the intersection of the wires into the optical axis is called the "adjustment of the line of collimation." This will be described further on. The openings in the telescope-tube are made considerably larger than the screws, so that, when these are loosened, the whole ring can be turned around for a short distance in either direction. The object of this will be seen more plainly when we describe the means by which the wire is made truly vertical. The sectional view of the telescope, Fig. 1, also shows two movable rings, one placed at A A, the other at C C, which are respectively used to effect the centering of the eye-piece and the adjustment of the object-glass slide. The centering of the eye-tube is performed after the wires have been adjusted, and is effected by moving the ring, by means of the screws shown on the outside of the tube, until the intersection of the wires is brought into the center of the field of view.

The adjustment of the object-slide, which will be hereafter described, secures the movement of the object-glass in a straight line, and thus keeps the line of collimation in adjustment through the whole range of the slide, preventing at the same time what is termed the "traveling" of the wires. This adjustment is always made in the process of construction, and, needing no further attention at the hands of the engineer, is concealed within the ring near the ball of the telescope-axis.

In Fig. 5 the telescope is represented as plain, or without any attachments, such as vertical circle, level, etc.; but many if not most engineers prefer to have two or more of these accessories, and it will be well to briefly describe the same in this connection.

The standards of the transit are firmly attached by their expanded bases to the upper plate, one of them having near the top, as shown in the drawing, a little movable box, actuated by a screw underneath, by which the telescope-axis is made truly horizontal, as will be hereafter described

The circular plates, with their accompanying sockets, are shown in section in Fig. 4; the upper plate, A A, carrying the compass-circle, etc., is screwed fast to the flange of the interior spindle; the lower plate or divided limb, B B, is fastened to the exterior socket C, which again is fitted to and turns in the hollow socket of the leveling-head. The compass-box, containing the needle, etc., is covered by a glass to exclude the moisture and air; the circle is silvered, and is divided on its upper surface or rim into degrees and half-degrees, the degree-marks being also cut down on its inner edge, and figured from 0 to 90 on each side of the center or line of zero.

The magnetic needle is four to five inches long in the different sizes of transits, its brass cap having inserted in it a little socket or center of hardened steel, perfectly polished, and this, resting upon the hardened and polished point of the center-pin, allows the needle to play freely in a horizontal direction and thus take its direction in the magnetic meridian. The needle has its north end designated by a scallop or other mark, and on its south end a small coil of fine brass wire, easily moved, so as to bring both ends of the needle to the same level. The needle is lifted from the pin by a concealed spring underneath the upper

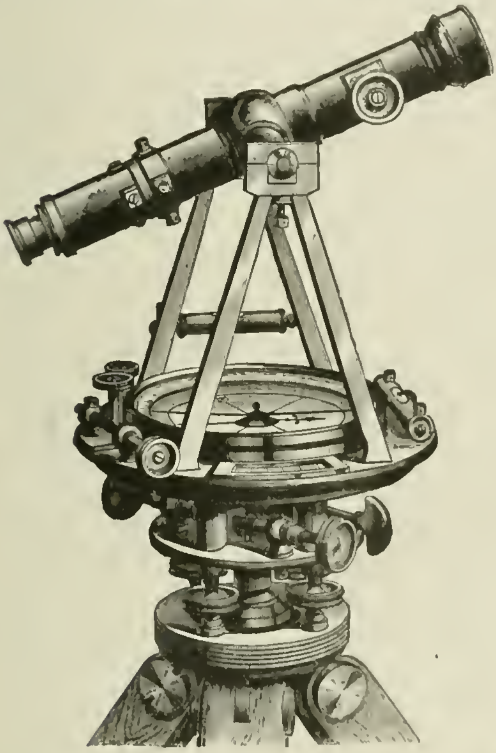


Fig. 5.

plate, actuated by a screw shown above, thus raising the button so as to check the vibrations of the needle, or bring it up against the glass when not in use, to avoid the unnecessary wear of the pivot. The forms of the needle are almost infinitely varied, according to the taste or fancy of the maker or surveyor, but may be resolved into two general classes, one having the greatest breadth in a horizontal, the other in a vertical, direction. The test of the delicacy of a magnetic needle is the number of horizontal vibrations which it will make in a certain arc before coming to rest; besides this most surveyors prefer also to see a sort of quivering motion in a vertical direction. This quality, which is manifested more in a horizontal than in a vertical needle, and depends upon the near coincidence of the point of suspension with the center of gravity of the needle, serves to show merely that the cap below is unobstructed.

The clamp and tangent movement, shown in Fig. 5, on the upper plate, serves to fasten the two plates together, so that by the tangent screw they can be slowly moved around each other in either direction, or loosened at will and moved by the hand, thus enabling one to direct the telescope rapidly and accurately to the point of sight. The opening for the clamp in the upper plate is covered by a plate or a washer, as shown, to exclude the dust and moisture. The clamping-piece into which the clamp-screw enters is shown at D, Fig. 4.

The two levels are shown placed at right angles to each other so as to level the plate in all directions, and adjusted by turning the capstan-head screws at their ends by a small steel adjusting-pin. The glass vials used in the levels of this transit are ground on their upper interior surface, so as to make the bubble move evenly and with great sensitiveness.

The lower plate or limb, BB, Fig. 4, is divided on its upper surface—usually into degrees and half-degrees—and figured in two rows, viz., from 0 to 360, and from 0 to 90 each way; sometimes but a single series is used, and then the figures run from 0 to 360, or from 0 to 180 on each side. The figuring is varied according to the wish of the engineer, the double series being always used unless otherwise desired. The two verniers, V V, are attached to the upper plate diametrically opposite to each other, and serve to read the limb around which they revolve.

The verniers are double, having on each side of the zero-mark thirty equal divisions corresponding precisely with twenty-nine half-degrees of the limb; they thus read to single minutes, and the number passed over is counted in the same direction in which the vernier is moved. The use of two opposite verniers in this and other instruments gives the means of "cross-questioning" the graduations, the perfection with which they are centered, and the dependence which can be placed upon the accuracy of the angles indicated. Sometimes a finer reading than minutes is desired, and then the divisions of the limb and vernier are both made smaller, so as to give readings to 30, 20, or even 10 seconds of arc, if required. The vernier-openings are covered with glass, carefully cemented to exclude the moisture and dust. Reflectors of silver or celluloid, as in the mountain-transit, are often used to throw more light upon the divisions, and, more rarely, shades of ground glass are employed to give a clear but more subdued light.

The graduations are made commonly on the brass surface of the limb, afterwards filled with black wax, and then finished and silvered. Many instruments, however, have a solid silver plate put over the brass and the graduations made on the silver itself. The last is more costly, but insures a finer graduation, with less liability to tarnish or change color.

The sockets of the transit, as shown in Fig. 4, are compound; the interior spindle attached to the vernier-plate turning in the exterior socket, C, when an angle is taken on the limb, but when the plates are clamped together the exterior socket itself, and with it the whole instrument, revolves in the socket of the leveling-head. The sockets are made with the greatest care, the surfaces being truly concentric with each other, and the bell-metal or composition of which they are composed of different degrees of hardness, so as to cause them to move upon each other easily and with the least possible wear.

The leveling-head, also shown in Fig. 4, consists of two plates connected together by a socket having at its end a hemispherical nut fitting into a corresponding cavity in the lower plate. The plates are inclined to each other or made parallel at will by four leveling-screws, of which only two are shown in the section. The screws are of bronze or hard composition metal and fitted to long nuts of brass, screwed into the upper parallel plate; and, as will be noticed, have threads only on the upper ends, the lower part of their stems turning closely in the lower unthreaded part of the nuts. By this arrangement dust is excluded from the lower end of the screws, while the brass cover above equally protects the other end. The screws rest in little cups or sockets, which are secured to their ends and in which they turn without marring the surface of the lower plate, the cups also permitting the screws to be shifted from side to side, or turned around in either direction on the lower plate.

The clamp and tangent movement of the leveling-head, partially shown in Fig. 5, serves to turn the whole instrument upon its sockets, so as to fix the telescope with precision upon any given point, and when unclamped allowing it to be directed approximately by hand. The tangent-screws, as will be seen, press on opposite sides of the clamp-piece, and thus insure a very fine and solid movement of the instrument.

The lower leveling-plate is made in two pieces—the upper one, which is screwed fast to the top of the tripod, having a large opening in its center, in which the smaller lower one is shifted from side to side or turned completely around. By this simple arrangement, termed a "shifting center," the instrument is easily moved over the upper plate, and the plummet which hangs from the center, P, Fig. 4, set precisely over a point, without moving the tripod.

The tripod, the top of which is shown in Fig. 5, has three mahogany legs, the upper ends of which are pressed firmly on each side of a strong tenon on the solid bronze head by a bolt and nut on opposite sides of the leg; the nut can also be screwed up at will by a wrench furnished for the purpose, and thus kept firm. The lower end of the leg has a brass shoe with an iron point, securely fastened and riveted to the wood.

Every instrument should leave the hands of the maker in complete adjustment; but all are so liable to derangement by accident or careless use that we deem it necessary to describe particularly those which are most likely to need attention. The principal adjustments of the transit are: 1. The levels; 2. The line of collimation; 3. The standards.

To adjust the levels, set up the instrument upon its tripod as nearly level as may be, and having unclamped the plates, bring the two levels above and on a line with the two pairs of leveling-screws; then with the thumb and first finger of each hand clasp the heads of two, opposite; and, turning both thumbs in or out, as may be needed, bring the bubble of the level directly over the screws, exactly to the center of the opening. Without moving the instrument proceed in the same manner to bring the other bubble to its center; after doing this, the level first corrected may be thrown a little out; bring it in again; and when both are in place, turn the instrument half-way around; if the bubbles both come to the center, they would need no correction, but if not, with the adjusting-pin turn the small screws at the end of the levels until the bubbles are moved over half the error; then bring the bubbles again into the center by the leveling-screws, and repeat the operation until the bubbles will remain in the center during a complete revolution of the instrument, and the adjustment will be complete. It should be remarked that in this as in most transits the level on the standards has a movement only at one end, the adjustment being made by abutting screws, which are loosened and tightened in turn, in moving the level.

To adjust the line of collimation,—i.e., to bring the intersection of the wires into the optical axis of the telescope, so that the instrument when placed in the middle of a straight line will, by the revolution of the telescope, cut its extremities—proceed as follows: Set the instrument firmly on the ground and level it carefully; and then having brought the wires into the focus of the eye-piece, adjust the object-glass on some well-defined point, as the edge of a chimney or other object, at a distance of from two hundred to five hundred feet; determine if the vertical wire is plumb, by clamping the instrument firmly and applying the wire to the vertical edge of a building, or observing if it will move parallel to a point taken a little to one side; should any deviation be manifested, loosen the cross-wire screws, and, by the pressure of the hand on the head outside the tube, move the ring around until the error is corrected. The wires being thus made respectively horizontal and vertical, fix their point of intersection on the object selected; clamp the instrument to the spindle, and having revolved the telescope, find or place some good object in the opposite direction, and at about the same distance from the instrument as the first object assumed. Great care should always be taken, in turning the telescope, that the position of the instrument upon the spindle is not in the slightest degree disturbed. Now, having found or placed an object which the vertical wire bisects, unclamp the instrument, turn it half-way around, and direct the telescope to the first object selected; having bisected this with the wires, again clamp the instrument, revolve the telescope, and note if the vertical wire bisects the second object observed. Should this happen, it will indicate that the wires are in adjustment, and the points bisected are, with that of the center of the instrument, in the same straight line. If not, however, the space which separates the wires from the second point observed will be double the deviation of that point from a true straight line, which may be conceived as drawn through the first point and the center of the instrument, since the error is the result of two observations, made with the wires when they are out of the optical axis of the telescope.

In order that the wires may trace a vertical line as the telescope is moved up or down, it is necessary that both the standards of the telescope should be of precisely the same height. To ascertain this and make the correction when needed, proceed as follows: Having the line of collimation previously adjusted, set up the instrument in a position where points of observation, such as the point and base of a lofty spire, can be selected, giving a long range in a vertical direction. Level the instrument, fix the wires on the top of the object and clamp to the spindle; then bring the telescope down until the wires bisect some good point, either found or marked at the base; turn the instrument half around, fix the wires on the lower point, clamp to the spindle, and raise the telescope to the highest object. If the wires bisect it, the vertical adjustment is effected; if they are thrown to either side, this would prove that the standard opposite that side was the highest, the apparent error being double that actually due to this cause. To correct it, one of the bearings of the axis is made movable, so that by turning a screw underneath this sliding piece, as well as the screws which hold on the cap of the standard, the adjustment is made with the utmost precision. This arrangement, which is common to all the best telescope-instruments, is very substantial and easily managed.

Besides the three adjustments already described—which are all that the surveyor will ordinarily have to make—there are those of the needle and the object-glass slide, which may sometimes be required. The first is given with the description of the compass. To adjust the object-glass slide: Having set up and leveled the instrument, the line of collimation being also adjusted for objects from three hundred to five hundred feet distant, clamp the plates securely, and fix the vertical cross-wire upon an object as distant as may be distinctly seen; then, without disturbing the instrument, throw out the object-glass, so as to bring the vertical wire upon an object as near as the range of the telescope will allow. Having this clearly in mind, unclamp the limb, turn the instrument half-way around, reverse the eye-end of the telescope, clamp the limb, and with the tangent-screw bring the vertical wire again upon the near object; then draw in the object-glass slide until the distant object first sighted upon is brought into distinct vision. If the vertical wire strikes the same line as at first, the slide is correct for both near and remote objects; and, being itself straight, for all distances. But if there be an error, proceed as follows: First, with the thumb and forefinger, twist off the thin brass tube that covers the screws, CC, shown in Fig. 1. Next, with the screwdriver, turn the two screws, CC, on the opposite *sides* of the telescope, loosening one and tightening the other, so as apparently to increase the error, making, by estimation, one half of the correction required.

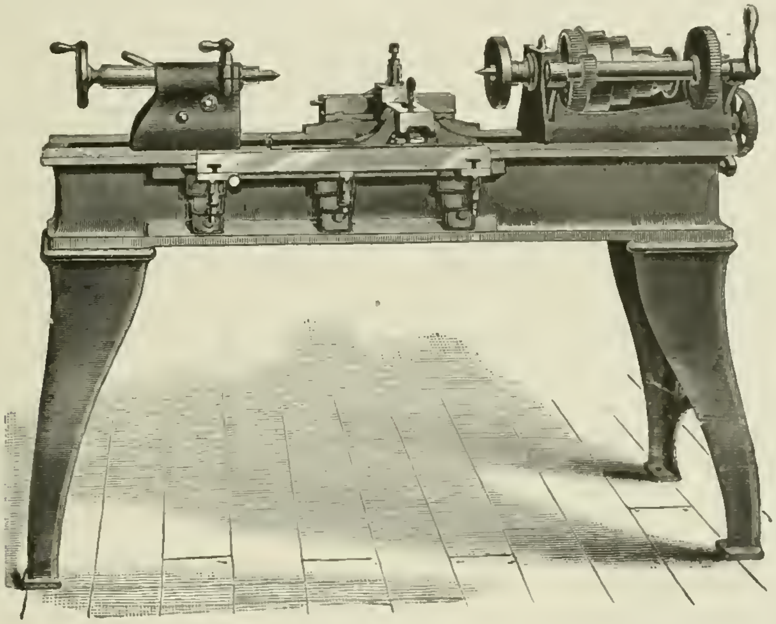
ENGLAND & WALES
SCALE OF MILES
0 5 10 20 30 40 50 60 70
Towns of upwards of 100,000
" inhabitants shown thus
" from 50,000 to 100,000
" from 10,000 to 50,000
" below 10,000
County Towns underlined
Railroads
Longitude West
from Greenwich
East
SCOTLAND
IRELAND
IRISH SEA
NORTH SEA
ENGLISH CHANNEL
BRISTOL CHANNEL
CARDIGAN SEA
ST GEORGE'S CHANNEL
NORTH CHANNEL
FRANCE
NORTHUMBERLAND
CUMBERLAND
WESTMORELAND
DURHAM
YORK
LANCASHIRE
STAFFORD
NORTHAMPTON
HUNTINGDON
CAMBRIDGE
SUFFOLK
RUTLAND
MIDDLESEX
HAMPSHIRE
SOMERSET
DORSET
SURREY
SUSSEX
KENT
WILTS
CARMARTHEN
PEMBROKE
BRECKNOCK
CARDIGAN
ANGLESEY
ISLE OF MAN
EDINBURGH
Glasgow
Berwick
Newcastle
South Shields
Sunderland
Tynemouth
Hartlepool
Whitby
Scarborough
Carlisle
Whitehaven
Lancaster
Blackpool
Preston
Hull
Birmingham
Cambridge
Cardiff
Bristol
Bath
Southampton
Portsmouth
Plymouth
Exeter
Brighton
Hastings
Dover
Lands End
Lizard Pt.
Dumfries
Hawick
Peebles
Ayr
Douglas
Holyhead
Dublin
Kingstown
Belfast
Calais
Boulogne
Dieppe
River Thames

Then go over the usual adjustment of the line of collimation, and having it completed, repeat the operation above described; first sighting upon the distant object, then finding a near one in line, and then reversing, making correction, etc., until the adjustment is complete. This adjustment is peculiar to the transits made by Messrs. W. and L. E. Gurley, of Troy, N. Y., and furnishes the only way in which the line of collimation can be made correct for all distances.

When using the transit, care should be taken to have it set up firmly, the tripod-legs being pressed into the ground, so as to bring the plates as nearly level as convenient; the plates should then be carefully leveled and properly clamped, the zeros of the verniers and limb brought into line by the upper tangent-screw, and the telescope directed to the object by the tangent-screws of leveling-head. The angles taken are then read off upon the limb, without subtracting from those given by the verniers, in any other position. Before an observation is made with the telescope, the eye-piece should be moved in or out, until the wires appear distinct to the eye of the operator; the object-glass is then adjusted by turning the pinion-head until the object is seen clear and well defined, and the wires appear as if fastened to its surface. The intersection of the wires. being the means by which the optical axis of the telescope is defined, should be brought precisely upon the center of the object to which the instrument is directed. The needle is used, as in the compass, to give the bearings of lines, and as a rough check upon the angles obtained by the verniers and limb; but its employment is only subsidiary to the general purposes of the transit. The instrument as described is manufactured by the Messrs. Gurley, United States. See *Mountain-transit, Prismatic Transit, Sextant, Solar Attachment, Solar Compass, Theodolite, Transit-instrument*, and *Y-level.*

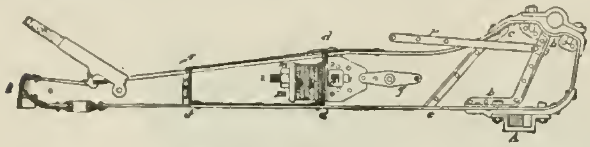
ENGINE-LATHE.—A lathe of the larger kind, having a capacity for all the principal turning work of the armory. That shown in the drawing is a 13-inch weighted engine-lathe, with screw and back gears. It swings 13 inches over the bed and 6 inches over the carriage. The front bearing of the head-stock spindle is $1\frac{3}{4}$ inch diameter and $3\frac{3}{4}$ inches long, in cast-iron boxes lined with Babbitt-metal. Screw-thread on spindle for face-plate $1\frac{3}{4}$ inch diameter, 8 pitch. The cone, largest diameter 9 inches, is driven by a belt 2 inches wide. The hole through the spindle is $\frac{9}{16}$ inch diameter. The small feed-gears are of wrought-iron. With the usual set of gears, screws may be cut with threads of 4 to 64 to the inch. Stationary and follow rests, countershaft, and wrenches accompany the lathe. Speed by countershaft, 9 by 3 inch friction-pulleys, 140 revolutions per minute. Lathe with 4-foot bed receives 1 foot 8 inches between centers, and weighs 1100 pounds. Beds 4 to 6 feet long.

A larger size of the same pattern swings 16 inches over the bed and 8 inches over the carriage. The front bearing of the live-spindle is $4\frac{1}{2}$ inches long by $2\frac{1}{4}$ inches diameter. The cone, largest diameter $12\frac{3}{4}$ inches, is driven by a belt $2\frac{1}{2}$ inches wide. The hole through the spindle is $\frac{9}{16}$ inch diameter; screw-thread on spindle for face-plate, $2\frac{1}{4}$ inches diameter, 6 pitch. With the usual set of gears, screws of from 3 to 48 threads to the inch may be cut. Speed of countershaft, 10 by 3 inch friction-pulleys, 120 revolutions per minute. This size of lathe is made, also, with gibbed carriage and cross-feed. It swings $10\frac{1}{2}$ inches over the carriage. Lathe with 5-foot bed receives 2 feet between centers, and weighs 1475 pounds. Beds 5 to 8 feet long. See *Lathe.*



Engine-lathe.

ENGLEHARDT GUN-CARRIAGE.—The great strain brought on the carriage by firing the large charges that are used in the new artillery renders the construction of the carriage a difficult problem, to be sure of the required strength without exceeding the limits of the weight hitherto deemed admissible, which cannot be exceeded without encountering grave objections in the service of the piece. Already many attempts have been made to lessen the shock on the carriage by the introduction of springs of different forms, intended to give a certain elasticity and avoid breakage. A carriage of this kind was exhibited at Vienna by the Bochum Company. The desired elasticity was obtained by the use of a Brown's spiral spring, arranged somewhat in the same manner as in Colonel Englehardt's carriage. Metallic springs are, at best, frail, subject to accidents, and otherwise objectionable; consequently this carriage does not seem to have found favor. Colonel Englehardt, of the artillery of the Imperial Guard, has experimented in Russia on a carriage of this kind, which, it appears from the experiments made, has given highly satisfactory results. The carriage is distinguished by its simplicity of construction, and is composed essentially of two parts, the carriage proper, and the slide and wheels. The carriage is formed of two cheeks of sheet-iron, the edges formed up and joined together by a lunette and four transoms, two of which, *bb*, *cc*, are between the cheeks, and two, *dd*, *ff*, are in the trail; these last also form the ends of the trail-chest, in which the elastic cushion is placed. The different details of the construction are given in the figure, in which the elevating-apparatus is not shown; only the stays, *p*, and the journals for its trunnions are represented. It will be sufficient to point out in the drawing the iron plate *t*, a kind of spade, riveted and bolted to the end of the trail, intended to penetrate the ground when the carriage is in battery, and to check the recoil. The part which the inventor designates by the term slide embraces the axle, A, with the wheels; it is joined by two rods, not shown in the drawing, to a strong cross-head, *g*. The axle-understraps, as well as the hole in



Englehardt Gun-carriage.

the trail for the cross-head, are sufficiently long to allow the pieces which work in them considerable play, so that the slide may move without imparting motion to the carriage. Under all other circumstances except violent shocks, produced by firing or by similar causes, the carriage and slide are united in an unalterable manner by means of an elastic cushion. This is composed of five strong sheets of cork, *h*, pressed between the transom *d* and a movable plate, *m*. The two strong bolts *i* pass through the whole and are secured to the cross-head, *g*. By turning the nuts on the ends of the bolts *i* any desirable initial compression may be brought on the sheets of cork. When the gun is discharged, the carriage, on account of the inertia of the slide, begins to slip, the resistance to which at the first moment brings into play the elasticity of the cork cushion. The inventor hopes that as the carriage proper alone receives the shock of the discharge, the whole system will suffer less fatigue. See *Field-carriages.*

ENGLISH FRICTION-PRIMER.—The tube is a quill; but as the material has not sufficient strength or firmness to resist the force of the pull necessary to withdraw the friction-wire, a loop of leather is attached to the quill which passes over a knob or projection cast on the gun just forward of the vent. The quill is destroyed by the combustion of the charge, and all accidents from the flying of the tube are obviated. The leather loop, however, is perishable and does not last for any great length of time. See *Friction-primer.*

ENGLISH FUSE.—The common name for the *Moorsom fuse.* It is very complicated in its construction, but a great importance is attached to it in England. See *Moorsom Fuse.*

ENGLISH SYSTEM OF RIFLING.—A modification of the French system, consisting of deep and broad grooves, each of which receives two soft-metal circular studs attached to the projectile. The grooves are three or more in number, according to the caliber of the piece; they are 1.05 inch wide, and .18 of an inch deep, with curved edges, both the loading and driving edges being struck with the same radius. The bottom of the grooves is eccentric to the bore, being struck with a radius of three inches; they are of the same width for all natures of heavy guns, but are a little deeper for the 10-inch gun and upwards; the grooves are also widened at the muzzle in the larger guns, in order to facilitate loading by cutting away the loading-side slightly for two inches from the muzzle. This system embraces uniform and increasing twists, the latter being preferred. Both the direction and twist are given by the bearing of the studs on the grooves, the body of the projectile never being intended to come into contact with the bore. The windage is .8 of an inch in all calibers. The projectiles have two studs for each groove in all instances; both studs in the case of the uniform twist, and the rear one where the twist is increasing, are nearly of the size of the groove, with their faces corresponding to the curved bottom of the groove. In the large projectiles an intermediate row has been introduced, making three rows in all, and a soft-metal gas-check has been applied to the base of the projectile. The rear stud is four inches from the bottom of the projectile, and the studs of each groove are equidistant from the center of gravity. The particulars of rifling are as follows: The 12-inch gun, 9 grooves; twist increasing from 1 in 100 to 1 in 50 calibers at muzzle. The 10 inch gun, 7 grooves; twist increasing from 1 in 100 to 1 in 40 calibers at muzzle. The 9-inch gun, 6 grooves; twist increasing from 0 to 1 in 45 calibers at muzzle. The 8-inch gun, 4 grooves; twist increasing from 0 to 1 in 40 calibers at muzzle. The 7-inch gun, 3 grooves; twist uniform, 1 in 35 calibers. The 7-inch gun has a uniform twist because, at the time of its introduction, the uniform was preferred to the increasing spiral. See *System of Rifling* and *Woolwich Gun.*

ENGRAILED.—In Heraldry, the line composed of a series of little half-moons, or semicircles, supposed to have been made in it by hail. Engrailed is the opposite of *inverted.* See *Heraldry.*

ENGUICHE.—A hunting-horn, the rim around the mouth of which is of a different color from the horn itself, is said heraldically to be *enguiché*, of the color in question. See *Heraldry.*

EN L'AIR.—Literally, in the air, unsupported. It is said that a division is *en l'air* when it is unsupported or too far from the army either to render assistance or to receive support. For instance, at the beginning of the war of 1870–71 General Douai was at Bellfort, MacMahon in the east of the Vosges, De Failly, *en l'air,* between Frossard and the Duke of Magenta.

ENLARGEMENT.—The act of going or being allowed to go beyond the prescribed limits; as the extending the boundaries of an arrest, when the officer is said to be enlarged, or under arrest at large. Enlargements of the bore and vent are injuries suffered by all cannon that are subjected to rapid and constant firing and erosion. When it becomes considerable, the vent is rebouched.

ENLISTMENT.—The mode by which the English army is supplied with troops, as distinguished from the conscription prevailing in many other countries. Enlistment was in private hands until the year 1802, middlemen procuring recruits, and receiving a profit or commission for their trouble. This system being subject to much abuse, the matter was taken into the hands of the Government in the above-named year, and is now managed by the Adjutant General. Formerly a soldier enlisted for life, and could never look forward to a period of freedom; or, at best, he could not retire on a pension while still possessed of a fair share of health and strength. This system was changed in 1847 by an Act relating to *limited* enlistment; which provided that a man should enlist for 10 years for the infantry, or for 12 for the cavalry or artillery. At the expiration of this period he could either quit the army, without pension; or re-enlist for the remainder of 21 years for the infantry, or 24 years for cavalry or artillery. This second period of service entitled the soldier to a pension for life, after his discharge: and in 1868 twopence a day was added to the pay of every soldier who re-enlisted (or re-engaged). This system of enlistment provided soldiers; but did nothing for the growth of trained reserves, with which to bring the army to fighting strength in the event of war. The "Army Enlistment Act" of 1870 seeks to remedy this defect, by allowing men to enlist for 12 years, with the understanding that 6 years or less shall be passed with the Colors, and the remainder with the Reserve. This is known as "short service." If apprentices enlist, the master may recover them under certain conditions detailed in the Mutiny Act (which is passed every year). The Mutiny Act also provides that servants enlisting before the term of their engagement are validly enlisted, and are entitled to wages up to the date of enlistment. Periods of imprisonment are not reckoned as part of the time of limited enlistment. A recruit enlists into either one of the 70 sub-district brigades, each of which comprises either a two-battalion regiment or two single-battalion regiments, or he enlists for general service in any regiment to which the Adjutant General may post him; but artificers, as armorers, etc., are usually enlisted for general service, so that their services may be made available where most required. The Army Discipline and Regulation Act of 1879 made several important alterations in regard to enlistment. The recruit had always to appear before a Magistrate, but formerly could not refuse to take the oath without paying a fine of 20*s*. Now he is not enlisted until he appear before the Magistrate, who causes to be read to him a series of authorized questions, and satisfies himself that the man is not under the influence of liquor, and voluntarily agrees to enlist. The recruit then signs the declaration, takes the oath, and is attested by the Magistrate. If the recruit does not so appear, or appearing does not assent, no further proceedings are taken. If within three months of his attestation a recruit pays a sum not exceeding £10, he is now entitled to be discharged.

Enlistment in the United States army is superintended by the Bureau of the Recruiting Service, the Chief Officer of which is stationed in New York City. There are quarters or branches in nearly all the large cities of the Union, and two Depots to which recruits are sent—Fort Columbus, New York Harbor, and the Barracks at Newport, Ky. Men are enlisted for five years, and may be assigned to any branch of the service.

The following is a list of the various "calls" for troops by the United States Government during the War of the Rebellion:

Date of Call.	Number of Men.	Term of Service.	Number obtained.
April 15, 1862	75,000	3 months	93,326
May to June 25, 1862	530,000	3 years	714,213
July 2, 1862	300,000	3 years	431,958
August 4, 1862	300,000	9 months	87,000
October 17, 1863	300,000	3 years }	374,807
February 1, 1864	200,000	3 years }	
March 14, 1864	200,000	3 years	284,021
July 18, 1864	500,000	1-2-3 years	384,882
December 19, 1861	300,000	1-2-3 years	204,568

There were other calls for 30 and 100 days' men. The whole number called for was 2,759,049; total obtained, 2,656,553. By Act of Congress March 3, 1863, called the "Conscription Act," the President was authorized to draft troops. The Act provided for an enrollment, a draft, the reception of substitutes, and arrest of deserters. About 3,000,000 men between the ages of 20 and 45 were enrolled. The calls from October 17, 1863, were orders for drafts. But probably not more than 50,000 drafted men performed personal service. Substitutes were obtained. The "Substitute Fund" of the Government, consisting of money paid in as a release from service, and which was used as a "bounty fund" for volunteers, amounted to $25,902,029.

ENNISKILLEN DRAGOONS.—A British regiment of horse: it was first instituted from the brave defenders of Enniskillen, in 1689.

ENROLL.—To place a man's name on the roll or nominal list of a body of soldiers. See *Enlistment*.

ENSCONCE.—A term generally signifying, in a military sense, to cover as with a fort.

ENSEIGNE.—The Colors. The French designate all warlike symbols under the term *enseigne;* but they again distinguish that word by the appellations of *Drapeaux*, Colors, and *Etendards*, Standards. *Drapeaux* or Colors are particularly characteristic of the infantry; *Etendards* or Standards belong to the cavalry.

ENSEMBLE.—Together: the exact execution of the same movements performed in the same manner and by the same motions. It is the union of all the men who compose a battalion, or several battalions or companies of infantry and cavalry, who are to act as if put in motion by the same spring. See *Cadence*.

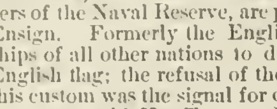
ENSIGN.—1. Until 1871 Ensign was the title of the lowest combatant rank of Commissioned Officers in the British army, and is derived from their being charged with the duty of carrying the Regimental Colors or Ensign. In the hand-to-hand mêlées of the Middle Ages, the preservation of the Colors or Standard, as the rallying-point of those fighting under the same leader, was a matter of vital importance, and was only intrusted to the bravest and most trustworthy. The Colors were committed to him with imposing ceremony in presence of the assembled regiment, and he had to take an oath to defend them with life and limb, and if need were, to wrap himself in them as a shroud, and devote himself to death. The man who undertook this perilous post received sometimes as much as sixfold the usual pay. It was doubtless in this way that the point of honor arose respecting the Colors. History records repeated instances where the oath was kept to the letter. In the modern system of warfare the Regimental Colors are seldom exposed to such danger, and the office of Ensign is of less account. In the infantry there were two kinds of Subalterns below the Captain, viz., the Lieutenant and the Ensign. In the cavalry and the artillery the duties of Ensign were taken by officers who had the titles of Cornet or Second Lieutenant. When a gentleman entered the army he began as an Ensign (if in the infantry), and from this rank he rose by purchase or seniority. The pay was 5*s*. 3*d*. per day, and the half-pay 1*s*. 10*d*. to 3*s*.; although it was most unusual for an Ensign to be on half-pay. An Ensign in the Foot-guards ranked as a Lieutenant in the army, and, on transferring his services to an infantry or cavalry regiment, exchanged with an officer of that grade.

The rank of Ensign having been abolished in the British army, the number of Lieutenants has been proportionately increased; but for three years the officer only receives the same pay as the Ensign formerly had. The officer enters in the probationary grade of Sub-lieutenant, which is converted to Lieutenant as soon as he proves himself qualified to command soldiers and perform the other duties of the office. In the late East India Company's army, a Cadet became an Ensign in rank and pay directly he landed in India.

2. In the United States navy an Ensign is the National Flag. It is also used in the merchant-service to designate the country to which the vessel belongs. There is an officer in the navy called Ensign who ranks below Master and above Midshipman. In the army and the militia an Ensign is assigned to each company, his duty being to carry the flag or standard of the company. Sometimes the duty falls to a Sergeant.

Ensign is also the name of one of the flags belonging to the British fleet; and, under that or some other name, to most other fleets. It is a large flag or banner hoisted on an Ensign staff, a long pole erected over the poop, or at the gaff when the ship is under sail. Its chief purpose is to denote the nation to which the ship belongs. The English Ensign has for a groundwork one of three colors—red, white, or blue—and bears the union double cross of St. George and St. Andrew, or Union Jack, in the upper corner next the mast (dexter-chief). The *white* Ensign is also divided into four quarters by a red cross of St. George, and is limited to ships-of-war. Merchant-vessels are only allowed to carry the *blue* Ensign; but yachts, if of clubs acknowledged by the Admiralty, colonial armed vessels, ships connected with Government Departments, and merchant-vessels commanded by officers of the Naval Reserve, are permitted to use the *red* Ensign. Formerly the English Admirals required ships of all other nations to dip their Ensigns to the English flag; the refusal of the Dutch to comply with this custom was the signal for one of Blake's bloodiest encounters with Van Tromp. See *Flags* and *Standard*.

ENTANGLEMENTS.— Every approach which an enemy might use to reach a work should be so obstructed as to keep him as long as possible under a close fire of musketry. The best thing for this purpose is wire entanglement, made by planting stout stakes, about $3\frac{1}{2}$ feet long, 2 feet in the ground and 7 feet apart, in quincunx order and in three or four lines, as shown in the drawing. Around the tops of these stakes, at from 12 to 18 inches from the ground, in notches prepared for the purpose, telegraph or other strong wire is very securely wound, extending from one stake to another. This obstacle is rapidly made, is difficult to remove, and can be injured but little by the fire of the enemy. A kind of abatis formed of trees, with the trunks cut half through, forms a very serious obstacle to the advance of an assailant.



ENTERPRISER.—An officer who undertakes or engages in any important and hazardous design.

ENTIRE.—A line of men in one continued row by the side of each other. When formed behind each other they are said to be in file. The usual expression is *rank entire*.

ENTONNOIR.—The cavity or hole which remains after the explosion of a mine. It likewise means the tin-case or port-fire which is used to convey the priming-powder into the vent of a cannon. See *Crater*.

ENTRENCH.—To construct hastily thrown-up field-works for the purpose of strengthening any force in position. When the ground is undulating, rocky, or woody, it is easy to avoid the enemy's sight and fire; but when it is bare and level, the art of entrenching is of first importance. The history of all battles of late years has shown the expediency of making use of natural shelter or constructing field-intrenchments. Not only is such artificial shelter necessary in action, but it is frequently invaluable for the purpose of concealing the troops before the fire has opened. A very slight parapet of newly excavated earth is sufficient to protect men from the effects of rifle-balls. Experiment shows that the penetration of the ball (service-rifle) at a range of 10 yards is 20 inches, and only 10 inches at 200 yards. After a little practice, each soldier will ascertain the form of pit that best suits and protects him. The depth need not be uniform, but should be at least 10 inches where the body rests, and 6 inches elsewhere. With a view to lessening the effect of the enemy's fire, the soldier should lie down well under and behind the cover. The soldier should never be separated from an intrenching-tool of some description. Many are the instances recorded where it was impossible to forward the intrenching-tools to the front until after the exigency for their use had passed, and the men were compelled to use tin plates, tin cans, fragments of canteens, knives, sticks, etc., in order to get temporary shelter from the enemy's most galling fire. See *Intrenchment*.

ENTREPOT.—An intermediate depot for the reception of stores and arms in a garrison town where there is no arsenal or magazine.

ENVELOPE.—The name applied to the continuous enceinte formed when the counter-guards of the bastions are joined to those of the ravelins.

ENVIRON.—In a military sense, to inclose or surround in a hostile manner; to hem in; to besiege.

EPARCH.—The Governor of a Province in ancient Greece, or Prefect of a region under the rule of Rome. In modern Greece a Province of the Kingdom is called a Monarchy, and a subdivision of a Monarchy an Eparchy. In Russia the term denotes the Diocese or Archdiocese of a Bishop or Archbishop.

EPAULE.—In fortification, the shoulder of a bastion, or the place where its face and flank meet and form the angle, called the angle of the shoulder.

EPAULEMENT.—In fortification, a portion of a battery or earthwork. The siege-batteries are generally shielded, at one end at least, by epaulements, forming an obtuse angle with the main line of the battery. The object is to protect the guns and gunners from a flanking fire. The name is often given erroneously to the parapet of the battery itself, but it applies properly to the flanking return only. Sometimes the whole of a small or secondary earthwork, including the battery and its flanks, is called an epaulement; and sometimes the name is given to an isolated breastwork intended to shield the cavalry employed in defending a body of besiegers. An epaule is the shoulder of a bastion, where one of the faces and one of the flanks meet: and this points to the proper meaning of epaulement, as a shoulder or flanking work. The following distinctions are usually observed: When the covering mass is so constructed as to afford the assailed a view and fire over the assailant's line of approach, it is termed a *parapet;* when intended simply as a screen or cover from the fire of the enemy, it is termed an *epaulement;* and when used to cover troops or guns from an enfilading fire on the flank or in the rear, it is known as a *traverse*. See *Parapet* and *Traverse*.

EPAULETS—EPAULETTES.—Shoulder-knots worn by military and naval officers, as the marks of distinction, and as ornaments. In the British navy the officers of and above the rank of Lieutenant wear epaulets of gold lace, one on each shoulder, Sub-lieutenants wearing one only. The ranks and degrees are marked in a very systematic way by means of crowns, anchors, and stars worked in silver on the epaulet, and also by the size of the cords of the epaulets itself. This decoration was formerly universal in the British army, officers wearing those of gold, men of worsted; but they were abolished during the Russian war, in consequence of the dangers to which officers thus easily marked out were exposed. It is retained by the French army alone of the armies of the great Powers. Epaulets are worn by General Officers in the United States service, as also by the officers of most militia organizations. The following patterns are prescribed for General Officers:—*For the General of the Army:* Of gold, with solid crescent; device—two silver embroidered stars, with five rays each, $1\frac{1}{2}$ inch in diameter, and the "Arms of the United States" embroidered in gold placed between them. *For a Lieutenant General:* Of gold, with solid crescent; device—three silver embroidered stars of five rays each, respectively $1\frac{1}{2}$, $1\frac{1}{4}$, and $1\frac{1}{8}$ inch in diameter. The largest placed in the center of the crescent; the others placed longitudinally on the strap and equidistant, ranging in order of size from the crescent. *For a Major General:* Same as for Lieutenant General, omitting smallest star, and the smaller of the two remaining stars placed in the center of the strap. *For a Brigadier General:* Same as for Lieutenant General, omitting everything but the largest star. See *Shoulder-knots*.

EPAULIERE.—A thick strap of leather employed in ancient times. It passed over the shoulder and sustained the cuirass, composed of two pieces, breast- and back-plate. See *Cuirass*.

EPEE DE PASSOT.—A very short sword of Italian origin, used in the fifteenth century, and very much like the *anelace*.

EPHEBI.—In Grecian antiquity, the name given to the Attic youth from the age of eighteen till they entered upon their twentieth year. During this period they served a sort of apprenticeship in arms, and were frequently sent, under the name of *peripoli*, to some of the frontier towns of Attica to keep watch against foreign invasion.

EPIBATÆ.—In Grecian antiquity, the name given to soldiers whose duty it was to fight on board ship. They corresponded almost exactly to the Marines of modern naval warfare. The term is sometimes found in Roman authors to denote the same class of soldiers, but the general phrase adopted by them is *milites classiarii*, or *socii navales*.

EPIGNARE.—A small variety of ordnance which does not exceed one pound in caliber.

EPIGONI.—A term which signifies the "heirs" or "descendants." It was applied to the Sons of the Seven Chiefs who conducted an expedition against Thebes to restore Polynices, and who were all killed except Adrastus. Ten years later, the Epigoni—namely, Alcmæon, Thersander, Diomedes, Ægialeus, Promachus, Sthenelus, and Euryalus—renewed the enterprise and took Thebes. The War of the Epigoni was celebrated by several ancient epic and dramatic poets.

EPINGLETTE.—A large iron needle with which the cartridge of any large piece of ordnance is pierced before it is primed.

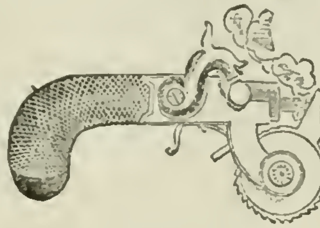
EPINIKIAN.—Pertaining to or celebrating victory; as, an epinikian ode.

EPITAGMA.—All the elementary tactical combinations, or *formations*, of the Greeks were methodical, but yet very simple. An army corps was composed of a *tetraphalangarchia*, also termed a grand phalanx, consisting of 16,354 oplitai. An *epitagma*, of 8192 psiloi; and an epitagma of cavalry of 4096 men. The heavy-armed or infantry of the line bore to the light infantry and cavalry the ratio of the numbers 2, 4, and 1. The epitagma of cavalry was divided into two equal parts, each composed alike, termed *telea*. One was placed on each wing of the line of battle. The telos was subdivided into 5 divisions; the strength of each subdivision being the half of the one next in order above it. The lowest, termed *ila*, of 64 horsemen, corresponding to the modern squadron, was drawn up on a front of 16 with 4 files, and was commanded by an officer to whom was given the title of *Ilarch*.

E PLURIBUS UNUM.—"One out of many." A motto adopted by the United States since the "Declaration of Independence," in 1776.

EPOUVANTE.—A sudden panic with which troops are seized, and under which they retreat without any actual necessity for so doing.

EPROUVETTE.—A machine for proving or testing the strength of gunpowder. It was invented or suggested in the last century by Robins, but was greatly improved by Dr. Hutton. The gun-eprouvette determines the strength of gunpowder by the amount of recoil produced. A small gun, usually a "half-pounder," is fixed to the lower end of an iron rod, its base being adjusted to an arm projecting from the rod; or else it is suspended from an iron frame. A horizontal steel axis is fixed to the rod or frame about which the gun may vibrate. A pointed iron rod or style projects downwards from the lower side of the gun, and touches a groove filled with soft wax; the groove is so shaped that, when the gun recoils, the point cuts a path for itself along this wax; and the length of this path determines the amount of recoil. Sometimes a brass graduated arc with an index is used instead of the pointed style and the waxed groove; but the principle of action is just the same. On the arc the recoil should vary from 26° for new fine-grain powder to 20° 5′ for old powder of coarse grain. This system of proof is resorted to annually at minor and foreign stations for the proof of all powder in store, to ascertain the amount of deterioration; five rounds constitute the minimum proof. Before the eprouvette is resorted to, the powder must pass the test of specific gravity, by weighing not less than 55 lbs. to the cubic foot. The mortar-eprouvette determines the strength of gunpowder by the distance to which a ball is projected, instead of the distance to which the piece recoils. It is generally a mortar of



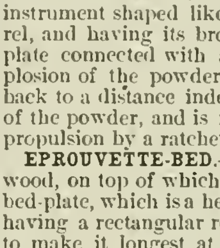
Eprouvette.

8-inch bore, in which 2 to 4 ounces of powder is employed to propel an accurately turned iron shot to a distance of about 120 yards. Other things being equal, the strongest gunpowder sends the shot to the greatest distance; and this is the usual mode adopted in testing gunpowder supplied to the Government by various contractors. The ordinary eprouvette is an instrument shaped like a small pistol without a barrel, and having its breech-chamber closed by a flat plate connected with a strong spring. On the explosion of the powder against the plate, it is driven back to a distance indexed according to the strength of the powder, and is retained at its extreme state of propulsion by a ratchet-wheel.

EPROUVETTE-BED.—This consists of a block of wood, on top of which is countersunk and bolted the bed-plate, which is a heavy circular plate of cast-iron, having a rectangular recess, with sloping sides, so as to make it longest at the bottom. Into this recess the sole of the mortar slides. The wooden block is bolted to a stone block of the same size, which is firmly placed in the ground on a masonry foundation. The bed is 22 inches long by 22 inches wide, and weighs 280 pounds. See *Platform*.

EQUALIZE.—To render the distribution of any number of men equal as to the component parts. To *equalize a battalion* is to tell off a certain number of companies, usually eight, in such a manner that the several component parts shall consist of the same number of men.

EQUATION OF DEFENSE.—Let A B C D represent the line of an interior crest; A B C D, that of the foot of the banquette slope; F, the outlet through the parapet; and E, the interior traverse. Representing



by x the number of yards in the side A B, the side A B will be equal to x diminished by twice the distance between A B and A B, which distance may be taken on an average at nine yards; the area of the square B C, or of the terre-plein, will then be represented by $(x-9)^2$. Let the following notation be adopted: y, the number of the garrison; r, the reserve taken from the garrison; n, the number of ranks on the banquette for the defense; s, the area of the terre-plein occupied by a barbette in the salient; s', the area occupied on the terre-plein by the powder-magazine; s'', the area occupied by the traverse, and the passage in its rear; l, the number of yards on the interior crest for a barbette in the salient; l', the width of the outlet F in yards. Now, as the area allowed for each man is one and a half square yards, we shall obtain the following equation, to represent the relation between the terre-plein, the garrison, etc.:

$$(x-9)^2 = 1.50\,y + s + s' + s'' \quad . \quad . \quad . \quad (1)$$

This is termed *the equation of the interior space*. As each man occupies one lineal yard along the interior crest, we obtain also

$$4x = \frac{y - r}{n} + l + l'; \quad . \quad . \quad . \quad . \quad . \quad (2)$$

which is termed *the equation of defense*, as it expresses the relation between the development of the interior crest, the remainder of the garrison after taking out the reserve, the number of ranks for the defense, and the length of the interior crest required for the cannon in barbette, and for the outlet. To show the application of the equations (1) and (2), let it be required to find the side of a redoubt, and the number of its garrison, which shall be defended by two ranks on the banquette, after taking out a reserve of one third of the whole number, and have a barbette in each salient. By a calculation, easily made, it can be shown that each barbette will occupy about seventy-five square yards of the terre-plein; a powder-magazine for four guns, twenty square yards; a traverse of earth, with the passage between it and the foot of the banquette, about 180 yards; or, if of timber, about fifty square yards; the portion of the interior crest for each barbette will be nearly eighteen lineal yards, and that for the passage about four lineal yards. Taking equation (2), and making the substitutions required by the conditions of the problem, we obtain

$$4x = \frac{y - \frac{1}{3}y}{2} + 4 + 72;$$

and from it, $y = 12x - 228.$

Substituting this value of y in equation (1), and placing for s, s', s'', their values, we have

$$(x - 9)^2 = 18x - 342 + 300 + 20 + 180,$$

or $$(x - 9)^2 = 18x + 158;$$

from which, by solving the equation,

$x = 38$ yards;
consequently $y = 228$ men,
and $r = 76$ men.

EQUATION OF TIME.—It is well known that the earth's motion in the ecliptic—or what is the same thing, the sun's apparent motion in longitude—is not uniform. This want of uniformity would of itself obviously cause an irregularity in the time of the sun's coming to the meridian on successive days; but besides this want of uniformity in the sun's apparent motion in the ecliptic, there is another cause of inequality in the time of its coming on the meridian, viz., the obliquity of the ecliptic to the equinoctial. Even if the sun moved in the equinoctial, there would be an inequality in this respect, owing to its want of uniform motion; and even if it moved uniformly in the ecliptic, there would be such an inequality, owing to the obliquity of its orbit to the equinoctial. These two independent causes conjointly produce the inequality in the time of its appearance on the meridian, the correction for which is the Equation of Time.

When the sun's center comes to the meridian, it is apparent noon; and if it moved uniformly on the equinoctial, this would always coincide with *mean noon*, or 12 o'clock on a good solar clock. But from the causes above explained, mean and apparent noon differ, the latter taking place sometimes as much as 16½ minutes before the former, and at others as much as 14½ minutes after. The difference for any day, called, as we have said, the Equation of Time, is to be found inserted in ephemerides for every day of the year. It is nothing or zero at four different times in the year, at which the whole mean and unequal motions exactly agree; viz., about the 15th of April, the 15th of June, the 31st of August, and the 24th of December. At all other times the sun is either too fast or too slow for clock-time. In the ephemerides above referred to, the sign + or − is prefixed to the equation of time, according as it is to be added to or subtracted from the apparent time to give the mean time. See *Time*.

EQUATIONS OF MOTION OF PROJECTILES.—In the article TRAJECTORY, the following relation between the co-ordinates of a point of the trajectory, the angle of projection, and the height due to the velocity is found to exist, viz.,

$$y = x \cdot \tan A - \frac{x^2}{4h \cdot \cos^2 A}. \quad . \quad . \quad . \quad (1)$$

V being the initial velocity, it is readily seen that

$$y = Vt \sin A - \tfrac{1}{2}gt^2; \quad . \quad . \quad . \quad . \quad (2)$$

also, $$x = Vt \cos A, \quad . \quad . \quad . \quad . \quad . \quad . \quad (3)$$

and $$t = \frac{x}{V \cos A}. \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (4)$$

To determine the vertical ascent and horizontal range of the projectile, differentiate equation (1), and place the value of $\frac{dy}{dx} = 0$; whence we obtain

$$X = 4h \sin A \cos A = 2h \sin 2A \quad . \quad . \quad (5)$$

$\frac{1}{2}X$ being the abscissa of the highest point,

$$Y = h \sin^2 A. \quad . \quad . \quad . \quad . \quad . \quad (6)$$

The first value of X shows that the range can be obtained with two angles of projection, provided they be complements of each other; the second value shows that the greatest range corresponds to an angle of 45°, and that this range is equal to twice the height due to the velocity; and also that variations in the angle of fire produce less variations in range as the angle of fire approaches 45°.

If two projectiles be thrown under the same angle, with different initial velocities, V and V', the ranges being X and X', we have

$$X = 2h \sin 2A = \frac{V^2}{g} \sin 2A, \quad \text{and} \quad X' = \frac{V'^2}{g} \sin 2A;$$

and from these we have

$$\frac{V}{V'} = \frac{\sqrt{X}}{\sqrt{X'}}. \quad . \quad . \quad . \quad . \quad . \quad . \quad (7)$$

Therefore, under the same angle of fire, the ranges are proportional to the squares of the velocities; and reciprocally, the velocities are proportional to the square roots of the ranges.

The velocity at any stated point is equal to $\frac{ds}{dt}$, or $v^2 = \frac{dy^2 + dx^2}{dt^2}$. Substituting the values of dy and dx obtained by differentiating equations (2) and (3), we have $v^2 = V^2 - 2Vgt \sin A + g^2t^2$. Substituting for $-2Vgt \sin A + g^2t^2$ its value $-2gy$ derived from equation (2), we have $v^2 = V^2 - 2gy$. Replace V^2 by $2gh$, and reducing, the expression becomes

$$v = \sqrt{2g(h - y)}, \quad . \quad . \quad . \quad . \quad (8)$$

This shows that the velocity of a projectile at any point depends on its height above the muzzle of the piece, and that it is equal to that which is attained in falling through the height $(h - y)$. It also shows that the velocity is least when y is greatest, or at the summit of the trajectory; and that the velocities at the two points in which the trajectory cuts the horizontal plane are equal.

The total time of flight may be determined by substituting the value of $X = 4h \sin A \cos A$, equation (5), in equation (4), which becomes

$$T = \frac{4h \sin A}{V} = \frac{V \sin A}{\frac{1}{2}g}. \quad . \quad . \quad . \quad . \quad (9)$$

If $A = 45°$, $\sin A = \sqrt{\tfrac{1}{2}}$, and $V = \sqrt{gX}$. Calling $T_{,}$ the time of flight, we have

$$T_{,} = \sqrt{\frac{X}{\frac{1}{2}g}} = \sqrt{\frac{X}{16.07}} = \tfrac{1}{4}\sqrt{X}.$$

Hence the time of flight for an angle of 45° is equal to the square root of the quotient of the range divided by one half of the force of gravity; or, it is approximately equal to one fourth of the square root of the range expressed in feet.

The tangent of the angle made by a tangent line at any point of the trajectory is equal to $\frac{dy}{dx}$, which is obtained by differentiating equation (1); calling this angle θ, we have

$$\tan\theta = \tan A - \frac{x}{2h\cos^2 A}. \quad . \quad . \quad . \quad (10)$$

Substitute the value of $X = 4h \sin A \cos A$, the angle of fall on horizontal ground is $\tan\theta = -\tan A$; that is to say, the angle of fall is equal to the angle of projection, measured in an opposite direction.

The position of a point being given, to find the initial velocity necessary to attain it. Let a and b be the horizontal and vertical co-ordinates of this point of the curve, and ε its angle of elevation. Substituting these quantities in equation (1), and recollecting that $\tan\varepsilon = \frac{b}{a}$, we have

$$h = \frac{a\cos\varepsilon}{4\sin(A-\varepsilon).\cos A},$$

or

$$V = \sqrt{\frac{ag\cos\varepsilon}{2\sin(A-\varepsilon).\cos A}}. \quad . \quad . \quad . \quad (11)$$

The position of a point being given, to find the angle of fire necessary to attain it. Substituting a and b for x and y in equation (1) we have

$$b = a\tan A - \frac{a^2}{4h\cos^2 A}$$

from which to determine A. Making $\tan A = \alpha$, we have $\cos^2 A = \frac{1}{1+\alpha^2}$; which being substituted in the above equation gives

$$\alpha = \tan A = \frac{1}{a}\left(2h \pm \sqrt{4h^2 - 4hb - a^2}\right). \quad (12)$$

The two values of tan A show that the point may be attained by two angles of projection; and the radical shows the solution of the problem is possible when the quantity under it is positive; or, $4h^2 > 4hb + a^2$.

The preceding formulæ will only be found to answer in practice for projectiles which experience slight resistance from the air, or for heavy projectiles moving with low velocities, as is commonly the case with those of mortars and howitzers. The following table gives the difference between the observed and calculated times of flight of the French 8- and 10-inch mortar-shells, weighing 64 and 119 pounds respectively. The initial velocities being unknown, the times are calculated from the observed ranges. The observed times are invariably greater than the calculated times, as might be expected from the resistance of the air, which retards the motion of projectiles.

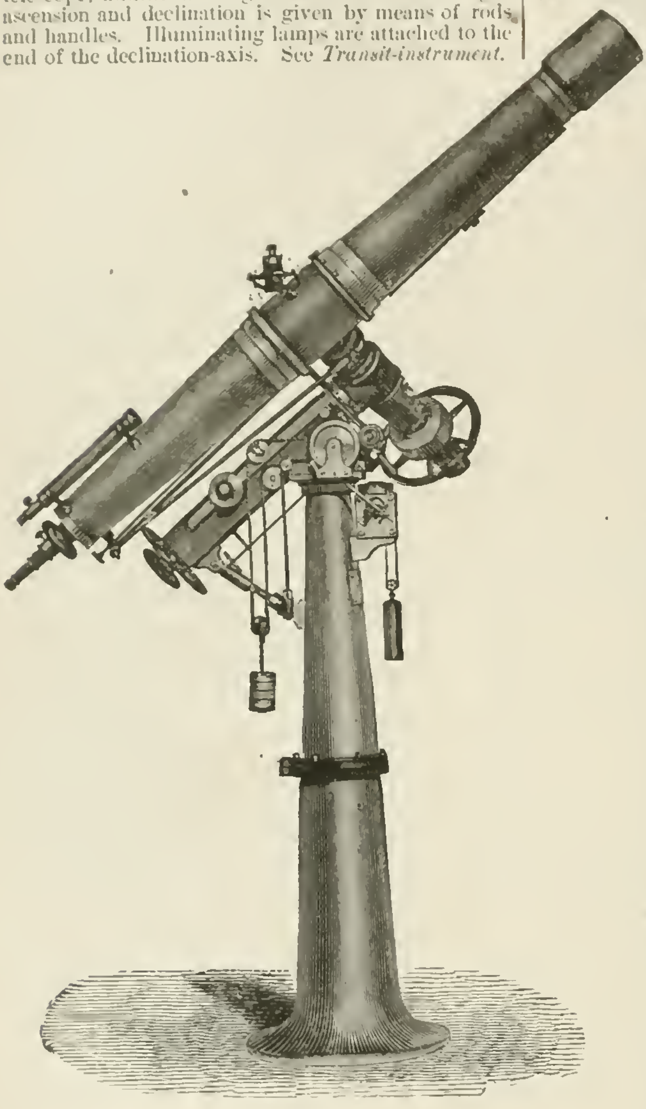
Kind of projectiles.	Weight of powder.	Ranges at angles of		Times of flight.			
				45°		30°	
		45°	30°	Observed	Calculated.	Observed	Calculated.
	Kilog.	Met'rs	Met'rs	Sec.	Sec.	Sec.	Sec.
8-inch..	0.234	343	290	9.8	8.4	6.8	5.8
	0.351	629	561	12.9	11.3	10.0	8.1
	0.585	1146	1011	16.0	15.3	12.3	10.9
	0.994	1792	1690	20.8	19.2	16.9	14.1
10-inch.	0.468	457	383	11.0	9.7	7.5	6.8
	0.693	734	637	14 0	12.2	10.0	8.7
	1.054	1132	980	17.0	15.2	12.0	10.2
	1.405	1555	1355	20.0	17.8	14 0	12.6
	1.639	1757	1516	23.0	18 9	15.0	13.4

The next table shows the observed and calculated ranges for 30° elevation, and the observed ranges for 45° elevation, for the above projectiles, the initial velocities being the same for each projectile.

Ranges of 10-in. Mortar-shells.				Ranges of 8-in. Mortar-shells.			
45° elevation.	30° elevation.			45° elevation.	30° elevation.		
Observed.	Observed	Calculated.	Difference.	Observed.	Observed	Calculated.	Difference.
Meters.	Met'rs	Met'rs	Met'rs	Meters.	Met'rs	Met'rs	Met'rs
457	383	396	+13	343	290	298	+ 8
734	637	637	0	629	561	545	−16
1132	980	982	+ 2	1146	1011	993	−18
1555	1355	1350	− 5	1792	1690	1552	−138
1757	1516	1522	+ 6				

It appears from the foregoing tables that the ranges of mortars with different degrees of elevation can be calculated up to about 1400 yards from equation (5), or $X = 2h \sin 2A$; and the times from equation (4); or $T = \frac{X}{V\cos A}$. See *Didion's Formulas*, *Resistance of the Air*, and *Trajectory*.

EQUATORIAL.—An important astronomical instrument, by which a celestial body may be observed at any point of its diurnal course. It consists of a telescope attached to a graduated circle, called the declination-circle, whose axis penetrates at right angles that of another graduated circle called the hour-circle, and is wholly supported by it. The pierced axis, which is called the principal axis of the instrument, turns on fixed supports; it is pointed to the pole of the heavens, and the hour-circle is of course parallel to the equinoctial. In this position it is easy to see that a great circle of the heavens, corresponding to the declination-circle, passes through the pole, and is an hour-circle of the heavens. The telescope is capable of being moved in the plane of the declination-circle. If, now, the instrument be so adjusted that the index of the declination-circle must point to zero when an equatorial star is in the center of the field of view of the telescope, and the index of the hour-circle must point to zero when the telescope is in the meridian of the place, it is clear that when the telescope is directed to any star, the index of the declination-circle will mark the declination of the star, and that on the other circle its right ascension. If the telescope be clamped when directed on a star, it is clear that, should the instrument be made to rotate on its principal axis with entire uniformity with the diurnal motion of the heavens, the star would always appear in the field of view. This motion of rotation is communicated to the instrument by clockwork. The drawing shows the instrument as made by Fauth and Company, United States. The telescope can be moved in right ascension without stopping the clock or disengaging the worm. When moved sufficiently the clock acts again with the regular rate, without previous clamping. If desired, an additional right-ascension circle is provided, driven by an auxiliary clockwork, which is kept running. An index shows the right ascension of the point to which the telescope is then directed. The rate of the driving-clock is readily changed from sidereal to lunar. The instrument is provided with a number of micrometrical and astronomical eye-pieces; transit eye-pieces and sun-shades; improved position micrometer, with parallactic eye-piece movement, fine movement for spider-line, and rapid movement for entire micrometer to traverse the field. The micrometer-head is divided on silver; the whole revolutions are read off on a separate dial, which, in our opinion, is the prettiest device for recording whole turns. The position-circle is divided on silver, reading by opposing verniers and microscopes to minutes or hundredths of a degree. Large declination and hour circles are divided on silver and read with two verniers and microscopes to five seconds of arc and single seconds of time respectively. A coarse graduation, with pointer, for convenience in setting, is put on the edge. The driving-clock with a conical pendulum is connected with the polar axis and can be thrown in and out of gear from the eye-end of the telescope; additional tangent-screw motion in right ascension and declination is given by means of rods and handles. Illuminating lamps are attached to the end of the declination-axis. See *Transit-instrument.*



Equatorial.

EQUERRY.—At the British Court, a subordinate officer under the Master of the Horse, who is usually a military man. There is a Chief Equerry, also four Equerries in ordinary, and an Equerry of the Crown Stables. Each member of the royal family has one or more Equerries.

EQUESTRIAN.—A man who rides on horseback. *Eques auratus* is a term in Heraldry for a knight.

EQUESTRIAN ORDER.—This body originally formed the cavalry of the Roman army, and is said to have been instituted by Romulus, who selected from the three principal Roman tribes 300 Equites. This number was afterward gradually increased to 3600, who were partly of patrician and partly of plebeian rank, and required to possess a certain amount of property. Each of these Equites received a horse from the State; but about 403 B.C. a new body of Equites began to make their appearance, who were obliged to furnish a horse at their own expense. These were probably wealthy *novi homines*, men of equestrian fortune, but not descended from the old Equites (for it should be observed that the equestrian dignity was hereditary). Until 123 B.C. the Equites were exclusively a military body; but in that year Caius Gracchus carried a measure by which all the *Judices* had to be selected from them. Then, for the first time, they became a distinct order or class in the State, and were called *Ordo Equestris.* In 70 B.C. Sulla deprived them of this privilege; but their power did not then decrease, as the forming of the public revenues appears to have fallen into their hands. After the conspiracy of Catiline, the Equestrian Order, which on that memorable occasion had vigorously supported the Consul Cicero, began to be looked upon as a third estate in the Republic; and to the title of *Senatus populusque Romanus* was added *et equestris ordo.* But, even in the beginning of the Empire, the honor, like many others, was so indiscriminately and profusely conferred that it fell into contempt, and the body gradually became extinct. As early as the later wars of the Republic, the Equites had ceased to constitute the common soldiers of the Roman cavalry, and figured only as officers.

EQUESTRIAN STATUE.—The representation of a man on horseback. Equestrian statues were awarded as a high honor to Military Commanders and persons of distinction in Rome, and latterly were, for the most part, restricted to the Emperors, the most famous in existence being that of the Emperor Marcus Aurelius, which now stands in the Piazza of the Capitol at Rome. It is the only ancient equestrian statue in bronze that has been preserved; an exemption which it probably owed to the fact that for centuries it was supposed to be a statue of Constantine. The action of the horse is so fine, and the air of motion so successfully given to it, that Michael Angelo is said to have called out to it "Cammina!" (Go on, then!). It was originally gilt, and traces of the gilding are still visible on the horse's head. So highly is this statue prized, not only for its artistic but its historical value, that an officer used regularly to be appointed by the Roman Government to take care of it, under the designation of the Custode del Cavallo. On the occasion of the rejoicings by which Rienzi's elevation to the Tribuneship was celebrated in 1347, wine was made to run out of one nostril and water out of the other of this famous horse. The statue then stood in front of the Church of St. John Lateran, near to which it was found, and a bunch of flowers has always been presented annually to the chapter of that basilica, in acknowledgment of ownership, since it was removed to its present site on the Capitol. All European capitals are adorned, or disfigured, by numerous equestrian statues, London belonging preeminently to the latter category.

EQUIP.—To furnish an individual, a corps, or an army with everything that is requisite for military service, such as arms, accouterments, uniforms, etc.

EQUIPAGE.—In military matters, the name given to certain of the necessaries for officers and soldiers. During the Crimean War many officers applied for and obtained money as compensation for the loss or injury of their equipage, comprising horses, horse-appointments, baggage, saddlery, and accouterments. Equipments issued to private soldiers are expected to last a certain number of years, and small deductions from their pay are made in the event of the articles

Equipment and Accoutrements. Flags, standards, sabrès, muskets, pikes, bayonets, helmets, caps, shakos, plumes, cuirasses, knapsacks, cartridge-belts, haversacks, sapping and mining tools, etc., of various European countries. *Russian:* **1**—1, 4, 12, 27; **2**—1; **3**—1, 2, 7, 10; **4**—2, 3, 9; **5**—3, 15, 16. *Austrian:* **1**—5, 9, 15, 21, 22, 27, 33, 37, 39, 43, 44; **2**—4, 9, 10, 12, 22; **3**—6, 11, 13; **5**—6. *Prussian:* **1**—6, 13, 14, 19, 29, 32, 34, 35, 38, 45, 46; **2**—6, 11, 13, 14, 16, 17, 18, 19, 20; **3**—4, 5, 9, 12, 14; **4**—7, 8, 10; **5**—12, 18, 20. *Saxony:* **1**—2, 3, 7, 18, 20, 36; **5**—4, 8. *French:* **1**—10, 26, 28, 40; **2**—8; **3**—13; **4**—12. *Wurtemberg:* **1**—11, 16. *Bavarian.* **1**—17; **4**—1, 11. *Danish:* **1**—23; **2**—7; **4**—6; **5**—7. *Braunschweig:* **1**—25, 31, 42; **2**—2, 5; **5**—5. *Hanover:* **2**—21. *Swedish:* **3**—3, 8. *English:* **4**—5; **5**—13. *Portugese:* **5**—1. *Spanish:* **5**—2.

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not lasting the proper time. In those cases (in the English army) where a non-commissioned officer receives a commission on the ground of meritorious service, an allowance of £100, if in the infantry, or £150, if in the cavalry, is made to him to provide an equipment. The equipage of a private soldier is often used as a name for the whole of his clothes, arms, and accouterments collectively. The *equipage* of an army is of two kinds: it includes all the furniture of the camp, such as tents and utensils, under the name of *camp-equipage;* while *field-equipage* comprises the saddle-horses, baggage-horses, and baggage-wagons.

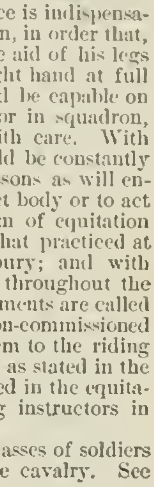
EQUIPMENT-FUND.—A fund for the benefit of Cadets graduating at the United States Military Academy. Four dollars per month is deposited with the Treasurer from the pay of each Cadet, to be applied, at the time of his promotion, to the purchase of a uniform and equipments. See *Cadet.*

EQUIPMENTS.—A general term signifying the arms and accouterments and all such articles as are worn or carried by the soldier; they are supplied by certain Departments charged with their administration. In the artillery service the term *equipment* includes the ordnance and carriages, the supply of ammunition and stores. In the cavalry, all articles of saddlery, and such as the horse carries, are included under this head. *Cannoneers' equipments* include the *hausse-pouch, cartridge-pouches, primer-pouches,* and *thumb-stall,* used in the field-service. The equipments for a field-piece are the *tampion* and *strap, vent-cover,* and *tarpaulin.* Other things used in the service of cannon are called implements. In the mounted service *horse-equipments* comprise the *bridle, halter, watering-bridle, saddle, saddle-bags, saddle-blanket, nose-bag, lariat, currycomb, brush,* etc. *Infantry equipments* comprise the personal outfit of the soldier, excluding the arms proper and clothing. A set of equipments is called a *kit.* The standard kit includes the *knapsack, belts* and *plates, cartridge-box, bayonet-scabbard, haversack,* and *canteen.* The knapsack, haversack, and canteen are only used when marching. In future wars it is probable that an intrenching-tool will be added to the soldier's equipment. *Signal equipments* comprise the *flags, staffs, flying-torches, foot-torches, flame-shades, haversacks, telescopes,* etc. In the United States the term *equipments* is most commonly applied to an officer's outfit, including especially those articles made of gold lace and cord. The supplying of equipments to the Army, Navy, and National Guard has developed into a trade of magnificent proportions. In this line the house of Horstmann Brothers & Co. take the lead. It was founded in 1815 by William. H. Horstmann, of Cassel, Germany, who had previously learned the art of silk-weaving in France. He was the first to introduce the Jacquard machine into this country, and applied power to the production of gold lace and other narrow textile fabrics several years before the attempt was made in Europe. After the death of the elder Mr. Horstmann, the business was continued by his sons, William J. and Sigmund Horstmann, who in 1852 built their factory in Philadelphia. The present owners of the business represent the third generation. In the factory are produced narrow textile fabrics of all kinds, military and society goods and trimmings, including swords, metal-work, leather-work, gold and silver embroidery, and a great variety of minor and miscellaneous articles. The Messrs. Horstmann have paid special attention to a very fine class of goods for the equipment of officers, and their experience of over sixty years in the production of their specialties has enabled them to bring the goods to a degree of perfection in finish which challenges comparison with any of foreign manufacture. Adjoining the factory are the offices and salesrooms of the firm, who give employment to over 500 persons. Independent of the facilities for manufacturing all articles needed for the Army, Navy, and National Guard, they also import direct from the best sources such materials (the production of which has not yet been attempted in this country) as are required in the manufacture of the various articles in the line of equipment. See *Accoutrements.*

EQUITATION.—The art of riding. Military equitation—the principles of which are the same for all classes of cavalry, a uniform system existing throughout the country—is described as consisting in the skillful and ready application of the aids with which the rider guides and controls his horse in all his paces, and in a settled balance of the body which enables him to preserve a firm seat in every variety of movement. The aids in horsemanship are the motions and proper application of the bridle-hand and legs to direct and determine the turnings and paces of the horse. Military equitation may be divided into three parts: 1st. The complete instruction of the recruit upon a trained horse, from the earliest to the last lessons. 2d. The training of the horse by skillful and experienced men. 3d. The practice of the recruit and remount horse at close files in the elementary parts of field-exercise to prepare them for instruction in the troop or squadron. This science is indispensably requisite for the military horseman, in order that, being able to govern his horse by the aid of his legs and bridle-hand, he may have the right hand at full liberty for the use of his weapon, and be capable on all occasions, whether acting singly or in squadron, of performing his various duties with care. With this view, both men and horses should be constantly practiced in the exercise of such lessons as will enable them either to move in a compact body or to act singly or independently. The system of equitation now taught in the English army is that practiced at the riding establishment at Canterbury; and with the view of maintaining one system throughout the country, Commanding Officers of regiments are called upon from time to time to select non-commissioned officers and soldiers, and to send them to the riding depot at Canterbury for the purpose, as stated in the Queen's Regulations, of being practiced in the equitation exercises, and trained as riding instructors in their corps. See *Horsemanship.*

EQUITES.—The first of the three classes of soldiers in the Roman army who formed the cavalry. See *Equestrian Order.*

ERASED.—*Erased* or *eradicated,* in Heraldry signifies that an object is plucked or torn off, and showing a ragged edge; as opposed to *coupé* or *coupy,* cut, which shows a smooth edge. A tree plucked up by the roots is said to be eradicated.



Erased.

ERICIUS.—In Roman antiquity, a military engine, so named from its resemblance to a hedgehog. It was a kind of chevaux-de-frise, placed as a defense at the gate of the camp.

ERICSSON GUN.—A gun with a solid wrought-iron barrel, forged from a very superior iron, and reinforced with a series of thin washers, forced on with accurately determined tension by hydrostatic pressure. Upon the end of the breech is forged a solid flange, against which the washers abut. The washers are cut out of ⅝-inch boiler-plate, and extend forward to the middle of the chase, where a nut, embracing and screwed upon the chase, presses them against the solid flange, and into close contact with each other. The following are the particulars of this gun:

Total length	152 inches.
Length of reinforce of washers	96 "
Length of maximum diameter	42 "
Maximum diameter	47 "
Diameter of muzzle	22 "
Diameter of bore	13 "
Diameter of barrel under reinforce	28⅛ "
Thickness of hoops or washers	⅝ "
Total thickness of wall of gun	17 "
Weight	47,000 pounds.

ERMIN.—An order of knights instituted in 1450 by Francis I., Duke of Bretagne, and which formerly subsisted in France. The collar of this order was of gold, and composed of ears of corn in saltire, at the end of which hung the ermine, with the inscription *A ma vie.* The order expired when the Dukedom of Bretagne was annexed to France.

ERMINE.—A white fur with black spots; the reverse of which, or a black fur with white spots, also used in Heraldry, is called *contre ermine.* Ermine is commonly used to difference the arms of any member of a family who is connected with the law. A cross composed of four ermine spots is said to be a cross ermine.

Ermine.

ERRARD DE BAR-LE-DUC SYSTEM OF FORTIFICATION.—This system limits the minimum of the salient angles at 60°, adopts 290 yards as the maximum of the line of defense, and fortifies on the exterior polygon. This system is inferior to the Italian, although it stands at the head of the French school. See *Fortification.*

ESCADRON.—A term more ancient than the word *battalion,* first employed by the French writer Froissart to signify a troop of horse drawn out in order of battle.

ESCALADE.—In siege operations, escalading is a mode of gaining admission within the enemy's works. It consists in advancing over the glacis and covered-way, descending, if necessary, into the ditch by means of ladders, and ascending to the parapet of the curtain and bastions by the same ladders differently placed. The ladders are either procured on the spot, or are sent out with the siege-army. A convenient form is in pieces of twelve feet length, fitting end to end by means of sockets. A firing-party is usually told off to keep down the fire of the enemy upon the escaladers, especially a flank fire lengthwise of the ditch, which might sweep them off with terrible rapidity. The following is the outline of the method of escalade proposed by Colonel Jebb of the Royal Engineers: Ladders of suitable length for the enterprise are to be provided for scaling the scarp; the one proposed is three feet longer than the height of the scarp, so that the foot of the ladder being planted a pace or two from the bottom of the wall, the top may project far enough above the wall to enable the men to step from the ladder with ease in an upright position. An allowance of one ladder is made for every five feet of the face to be scaled; one hundred feet, for example, requiring twenty ladders. To each ladder from four to six men are assigned, according to its length. The ladders are borne in the usual manner on the shoulders of the men, two or three being placed on each side for this purpose. The ladders for scaling the scarp are assigned to the advance. A second set of less dimensions, for descending into the ditch only, are assigned to the support. The scarp-ladders are placed on the ground in line at some suitable point, with the proper intervals between them; the men to carry them, properly "told off," are drawn up in rear of them, and at the proper commands are marched to their places at the sides of the ladders, and raise them ready for the forward movement. Similar dispositions are made for the counterscarp-ladders, which are placed in line from 100 to 150 yards in rear of the others. At a given signal the whole are to move forward, covered by an advanced firing-party to keep down the fire of the work, and followed by a reserve. The scarp-ladders are let down into the ditch, the men descend, carry them across it, plant them against the scarp, and mount to the top. The top of the parapet gained, the men are to group themselves rapidly in *rallying-columns,* and proceed to clear the parapet by charging the assailed in flank. The support and reserve, in the mean time, are to follow on without loss of time to take their share in the action.

Troops properly exercised in *gymnastics* are capable of mounting high walls with arms and accouterments, and without the use of ladders. Most armies have realized the necessity of gymnastic training, and have adopted definite systems. The drawing shows a few combinations which might after a little practice assist recruits or poor climbers in mounting walls and entering the upper windows of houses. In all such attempts the light weights should be selected for the highest story, and the basement-story should consist of a sufficient number of men to render the support strong and the climbing easy. Precipitous rocks may be escaladed by grasping bushes and roots, or by planting the bayonet in the crevices of the rocks, in order to reach the top. Such escalades are very dangerous when an enemy defends the height, as heavy stones may be rolled down upon the assailants; but activity and ingenuity accomplish very much, as was shown by the French in the attack upon Fort Scharnitz near Innspruck. They tied their haversacks round their heads, and, protected by this buckler, they scrambled up the rocks, despite the stones precipitated upon them. And still later the difficult ascent at Alma was scaled by French troops in the face of Russian artillery and infantry.

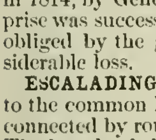
The most favorable time for a *surprise* is that of a winter night, when there is no moon. A long march may then be made without discovery, and the troops may arrive an *hour before day.* This is the propitious moment for the execution of the design. It is then that men sleep most profoundly; and it is at that hour the attacking force may begin in the dark and end the work by daylight; such favorable circumstances are much increased by heavy wind and rain during the night, as the clanking of arms and other inevitable noises made by the troops cannot be heard by the garrison, and the latter besides are more disposed to negligence. It is extremely important for the men to be able to recognize each other in the darkness, and the simplest means of doing so is to put the shirt outside the dress, or to tie a white band around the arm. The party must be furnished with petards, axes, and levers, to force open doors; with beams and ladders, to overthrow and scale walls. Hurdles and fascines are necessary to cross muddy ditches, or broad planks may be used as a substitute for hurdles. With fascines small ditches and pools are filled up. All these articles should be carried by the men from the last halting-place. Wagons and animals would lead to discovery, and are therefore left at a safe distance, while every precaution is taken to maintain silence in the assailing party. The soldiers should also not light their pipes, as the fire can be seen from a long distance in the dark. Barking dogs must be disposed of or quieted without the use of fire-arms, and every one must be on the alert.

The dispositions made for the attack will vary with circumstances, but in general it is well to divide the force into three parts: the first to penetrate into the city; the second to remain without and protect, if necessary, the retreat of the first; and the third to take such position as is most likely to prevent aid from reaching the enemy. When the first division has penetrated the city by escalade or otherwise, it surrounds at once some of the adjacent quarters, and holds the outlets of the principal streets, whilst detachments quickly open the gates to the troops outside, after having taken or killed the guards. As soon as the gates are opened, and sufficient numbers are at hand, the troops spread themselves in the city, after leaving good reserves upon which to retreat in case of check. The house of the Commandant, barracks, arsenal, and the guards of the interior are at once sought to prevent, if possible, any reunion of the defenders, and to paralyze all their efforts by the seizure of the Commanding Officer. If time and means of recovering from his stupor and concentrating his force in the interior of the city be left to the enemy, great risk will be run of being driven out, as the attacking force is necessarily everywhere weak, from the great number of points occupied. The famous example of Cremona, where Prince Eugene, after having made himself master of a great part of the city, and after having seized Marshal Villeroi, who commanded there, was nevertheless then driven out by the defenders, shows that all is not lost to the defenders when the enemy has seized the exterior posts. Another example may be cited in the surprise of Bergen-op-Zoom in 1814, by General Graham, where, although the surprise was successful, yet the assailants in the end were obliged by the garrison to surrender after very considerable loss.

ESCALADING LADDERS.—Frames of wood, similar to the common ladder, consisting of two side pieces, connected by rounds or steps, and sometimes by rope. The length of the ladders should be relative to that of the works or the walls to be escaladed. They are sometimes made in two or three parts, so that they may be more conveniently carried. There are two kinds of escalading ladders; those in lengths provided by Government with other engineers' stores, and those of an impromptu kind, made for the occasion. The first description consists of ladders about 12 feet in length, which fit into one another, so that each joint will give an effective length of 10 feet. The second description of ladder is in one length, which is difficult of carriage. In India, escalading ladders are made of two longitudinal pieces of bamboo, the transverse pieces of wood being let into the bamboo, and bound round it with strong rope. They are of two sizes, 26 feet and 14 feet long. See *Escalade*.

ESCALE.—A machine used in ancient times to pry the petard. Now obsolete. See *Petard*.

ESCALOP-SHELLS.—These are often used in Heraldry to signify that the bearer has made many long voyages by sea. As the Pilgrim's emblem, they were commonly given to those who had been to the Crusades; they came to be regarded as indicating either that the bearer or his ancestor had been a Crusader. The escalop-shell was the emblem of St. James the Great, and is generally met with in churches dedicated to him. The more ordinary form of the name is *scallop-shell*. See *Heraldry*.



Escalop-shells.

ESCARP.—In fortification, the surface of the ditch next the rampart, the surface next the enemy being termed the *counterscarp*. See *Scarp*.

ESCARPMENT.—Ground cut away nearly vertically about a position, in order to render it inaccessible to the enemy. See *Ditch* and *Scarp*.

ESCOPETTE.—A carbine, an improvement on the early hand-culverins or *sclopos*.

ESCORT.—A body of troops attending an individual as a guard. The term is also applied to a guard placed over prisoners on a march, to prevent their escape, and to the guard of a convoy of stores.

ESCORT OF HONOR.—Escorts of honor are detailed for the purpose of receiving and escorting personages of high rank, civil or military. The troops for this purpose are selected for their soldierly appearance and superior discipline. The escort forms in line, bayonets fixed, the center opposite the place where the personage presents himself, with an interval between the wings to receive him and his staff, the band on the flank of the escort toward which it will march. On the appearance of the personage, he is received with the honors due to his rank. When he has taken his place in the line, the escort is formed into column of companies, platoons, or fours, and takes up the march. On leaving, the escort line is formed, and the same honors are paid as before. When the position of the escort is at a considerable distance from the point where the person is to be received, as, for instance, where a court-yard or wharf intervenes, a double line of sentinels is posted from that point to the escort, facing inward; the sentinels successively salute as he passes, and are then relieved and join the escort. An officer is appointed to attend him, to bear such communications as he may have to make to the Commander of the escort. See *Funeral Honors*.

ESCORT OF THE COLOR.—The military ceremony of sending for and receiving the colors of a battalion. The battalion being in line, the Colonel after bringing the battalion to *carry arms* details a company, other than the color-company, to receive and escort the colors to their place in line. The escort is formed in column of platoons; the band in front, the Color-bearer between the platoons. The escort is then put in march, without music, arms at a *right shoulder*. On approaching the Colonel's quarters, the escort is halted and formed in line facing towards them, the band on the right, the Color-bearer in the line of file-closers. The moment the escort is in line, the Color-bearer, preceded by the First Lieutenant and followed by a Sergeant of the escort, goes to receive the color. When the Color-bearer comes out, followed by the Lieutenant and Sergeant, he halts before the entrance; the escort *presents arms*, and the trumpeters, or field-music, sound *to the color*. The Captain then causes the arms to be *carried;* the Lieutenant and Sergeant return to their posts, and the Captain breaks the company into column of platoons; the Color-bearer places himself between the platoons. The escort marches back to the battalion to the sound of music, in quick time, and in the same order as above, the guide to the left. The march is so conducted that, when the escort arrives at fifty yards in front of the right of the battalion, the direction of the march may be parallel to its front; when the color arrives opposite its place in line, the Captain forms line to the left and halts; the Color-bearer, passing between the platoons, advances and halts twelve yards in front of the Colonel. The Color-bearer having halted, the Colonel, who posts himself twelve yards in front of the center of his battalion, faces about, commands, 1. *Present*, 2. ARMS, resumes his front and salutes; the trumpeters, or field-music, sound *to the color*, and the Color-sergeant returns the color-salute. The Colonel then faces about, brings the battalion to a *carry*, after which the Color-bearer takes his place in the color-guard. The escort *presents* and *carries arms* with the battalion at the command of the Colonel, after which the Captain forms it again in column, and marches it to its place in line, passing around the left flank of the battalion. The color is escorted from the parade-ground of the color-company to the Colonel's quarters, by the color-guard.

The ceremony of escorting the *standard* is as follows: The regiment being in line, the Colonel, after bringing the regiment to *carry saber*, details a company, other than the color-company, to receive and escort the standard to its place in line. The escort is formed in column of platoons; the band in front, the Standard-bearer between the platoons. The escort is then put in march, without music. On approaching the Colonel's quarters, the escort is halted and formed in line facing toward them, the band on the right, the Standard-bearer in the line of file-closers. The escort being in line, the First Lieutenant, Standard-bearer, and the Right Principal Guide dismount in front of the Colonel's quarters, their horses being held by a trumpeter; the Standard-bearer, preceded by the First Lieutenant and followed by a Sergeant of the escort, then goes to receive the standard. When the Standard-bearer comes out, followed by the Lieutenant and Sergeant, they halt before the entrance and mount, the Lieutenant on the right, Sergeant on the left; the trumpeter returns to his post; the Captain then commands, 1. *Present*, 2. SABER; the escort *presents saber*, and the trumpeters sound *to the standard*. The Captain then causes the saber to be *carried*; the Lieutenant and Sergeant return to their posts, and the Captain breaks the company into column of platoons; the Standard-bearer places himself between the platoons. The escort marches back to the regiment to the sound of music, and in the same order as above, the guide to the left. The march is so conducted that, when the escort arrives at fifty yards in front of the right of the regiment, the direction of the march may be parallel to its front; when the standard arrives opposite its place in line, the Captain forms line to the left and halts; the Standard-bearer, passing between the platoons, advances and halts twelve yards in front of the Colonel. The Standard-bearer having halted, the Colonel, who, posts himself twelve yards in front of the center of his regiment, faces about, commands, 1. *Present*, 2 SABER, resumes his front and salutes; the trumpeters sound *to the Standard*, and the Standard-bearer returns the salute of the standard. The Colonel then faces about, brings the regiment to a *carry*, after which the Standard bearer, passing through the interval to the left of his company, wheels to the left about, and takes his place in the guard of the standard. The escort *presents* and *carries sabers* with the regiment at the command of the Colonel, after which the Captain forms it again in column, and marches it to its place in line, passing around the left flank of the regiment.

ESCOUADE.—A term which signified, in the old French service, the third part of a company of foot or a detachment. Companies were divided in this manner for the purpose of more conveniently keeping the tour of duty among the men. We have corrupted the term and call it a *squad*.

ESCOUAGE.—An ancient feudal tenure by which the tenant was bound to follow his lord to war or to defend his castle. The term is also used for the commutation of personal service into a money payment, such as is observed in the case of a substitute where compulsory service is enacted.

ESCUTCHEON OF PRETENSE.—A small shield placed in the center of the larger one, and covering a portion of the charges on the latter, in which a man carries the arms of his wife when she is the heiress of her family. It is said to be carried *surtout*, or over-all. Sometimes also a shield over-all is given as a reward of honor; thus, the Earl of Stirling did bear two coats quarterly, and over all an inescutcheon of Nova Scotia, because he was the first planter of it. Usually written *Inescutcheon*.

ESPADON.—In old military works, a kind of two-handed sword, having two edges, of a great length and breadth; formerly used by the Spanish. Recently the term has been applied to all double-edged weapons.

ESPAULIERE.—A defense for the shoulder, composed of flexible, overlapping plates of metal, used in the fifteenth century; the origin of the modern *epaulette*.

ESPINGARD.—An ancient name for a very small gun under a 1-pounder, and in use as early as the fourteenth century. Also written *Epingare*.

ESPINGOLE.—A kind of blunderbuss which, in early times, was loaded with several balls; the charges were separated from each other by tampions in which holes were made, and thus the balls were fired in succession. See *Blunderbuss*.

ESPLANADE.—In fortification, the open space intentionally left between the houses of a city and the glacis of its citadel. It requires to be at least 800 paces broad, that the enemy, in case of his getting possession of the town, may not be able to assail the citadel under cover of the nearest houses. For this purpose the citadel must command the esplanade, and be able to send a direct fire into the streets opening upon it. In old works on fortification the term is often applied to the glacis of the counterscarp, or the slope of the parapet of the covered-way towards the country. See *Fortification*.

ESPONTOON.—A sort of half-pike, about 3 feet in length, used in the seventeenth century. The Colonels of Corps, as well as the Captains of Companies, always used them in action. This weapon was also used by officers in the British army.

ESPRINGAL.—In the military engineering of the days before the introduction of gunpowder in European warfare, a machine for throwing missiles. These missiles were either large darts called *muchettes*, or arrows winged with brass, and called *viretons* from their whirling motion when shot forth. Also written *Springal*.

ESPRIT DE CORPS.—A term generally used among military men. It may not improperly be defined a laudable spirit of ambition which produces a peculiar attachment to any particular corps, company, or service. Officers, without descending to mean and pitiful sensations of selfish envy, under the influence of a true *esprit de corps* rise into an emulous thirst after military glory. The good are excited to peculiar feats of valor by the sentiments it engenders, and the bad are deterred from ever hazarding a disgraceful action by a secret consciousness of the duties it prescribes.

ESQUIRE.—The Esquire in Chivalry was the Shield-bearer or Armor-bearer to the Knight, and hence was called *Armiger* in Latin. He was a candidate for the honor of knighthood, and thus stood to the Knight in the relation of a novice or apprentice, pretty much as the page did to him. In this capacity he was spoken of as a Bachelor, just as the Knight Bachelor came latterly to be distinguished from him who had already attained to the higher honors of Chivalry. When fully equipped, each Knight was attended by two Esquires. The Esquire was a gentleman, and had the right of bearing arms on his own shield or escutcheon, which is surmounted by a helmet placed sideways, with its visor closed, to distinguish him from a Knight or Nobleman. He had also the sword, the emblem of Chivalry, though he was not girded with the knightly belt. His spurs were silver, to distinguish them from the golden spurs of the Knight; and when the King created Esquires of old, it was by putting silver spurs on their heels, and collars of SS round their necks. Those who received this honor directly from the Sovereign were in general the Esquires for the King's body, or those whose duty it was to attend him in his capacity of a Knight; an office now nearly obsolete. Tenants of the Crown who held by Knight's Service were a class of Feudal Esquires generally supposed to correspond to the simple *Ritters* or Knights of Germany, as opposed to the *Ritters* who were *geschlagen* or dubbed, inasmuch as these English Esquires were entitled to claim the rank of knighthood. Though the title of Esquire has now come to be given without discrimination to all persons above the rank of a tradesman or shop-keeper, the following seem to be those whose claim to it stands on the ground either of legal right or of long-established courtesy: 1. All the untitled sons of Noblemen; 2. The eldest sons of Knights and Baronets; 3. The sons of the younger sons of Dukes and Marquises, and their eldest sons. All these are Esquires by birth. Then there are Esquires by profession, whose rank does not descend to their children; and Esquires by office—e.g., Justices of the Peace—who enjoy the title only during their tenure of office. To the former class belong Officers in the Army and Navy, Barristers, and Doctors of Law, and Doctors of Medicine, but not Surgeons.

ESSEDARII.—In Roman antiquity, gladiators who fought in a heavy kind of chariot called *esseda* or *essedum*. The esseda differed from the *currus* in being open before instead of behind, and in this way the owner was enabled to run along the pole, from the extremity of which, or even from the top of the yoke, he discharged his missiles with surprising dexterity.

ESTABLISH.—A technical phrase to express the quartering of any considerable body of troops in a country. Thus it is common to say the army took up a position in the neighborhood of ——, and established the headquarters at ——. The term is also used in the sense of posting guides, markers, etc.

ESTABLISHMENT.—The extent, *matériel*, and *personnel* allowed to an army in peace or war time; in the latter case it is regulated according to the exigencies of the service, which being much greater during war than peace has given rise to the distinction of a *war* and a *peace establishment*.

ESTACADE.—A dike constructed of piles in the sea, a river, or a morass, frequently used to check the approach of an enemy.

ESTAFETTE.—A military courier who is sent express from one part of an army for a given time.

ESTIMATE.—A computation of the probable expense of any project or charges to be incurred, framed on any recognized data, derived from previous experience, such as the yearly military and other estimates of the country.

ESTIMATION OF DISTANCE.—In all circumstances where ordnance is employed, whether in the field or on the water, a knowledge of the distance is the essential element of correct practice. When considerable, it is usually estimated very vaguely; but the necessity of knowing it as correctly as possible at long ranges is greater than when the trajectory is nearly flat as in short ranges, elevation being given according to the distance, and inaccuracy increasing with length of range. At considerable distances, also, there is more leisure and opportunity, as well as greater necessity, for determining those distances with precision, while in closer action all that is required is to be certain that the enemy is within range at level. Distances may be estimated by several methods: 1st. By sight. 2d. By means of topographical maps. 3d. By the aid of special instruments for measuring angles. 4th. By the propagation of sound.

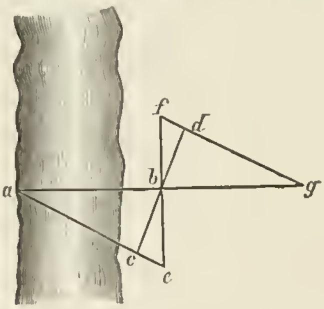
As in the excitement of action the employment of instruments is very difficult, it is desirable that every officer and soldier should be able to judge of distances by the eye. Under conditions favorable to observation, long practice enables an observer to estimate immediately and quite closely the position of an object within the distance of 500 yards. Beyond this limit, the variable condition of the atmosphere, as well as the form and nature of the ground, lead the most practiced observer into considerable error. A knowledge of the parts of objects visible at certain distances is necessary; but as this will vary with the power of the eye, each must, by comparison and reflection, establish a standard of his own. In ordinary weather, good sight admits of—1st. Counting the windows of a house at 4300 yards; 2d. Perceiving men and horses at 2200 yards; 3d. Distinguishing clearly infantry from cavalry at 1300 yards; 4th. Seeing the movements of men at 800 yards; 5th. Distinguishing the head and hat of a man at 550 yards; 6th. Seeing faces and principal parts of uniform at 300 yards. Objects always appear too near when seen distinctly outlined or against a bright background, as when the observer has the sun at his back, or when the air is particularly clear, as after a rain. Distances are underestimated also when the ground is uniform and offers no prominent points for reference. On the contrary, objects appear too reomte when obscure and indistinct. This occurs if the sun be in one's face, and if the weather be cloudy or foggy. Distances are also overestimated when the ground is undulating, cut by ravines, or covered with trees or dwellings.

Distances are most frequently estimated by special instruments. The simplest of these instruments are stadias and thread-micrometer or double-image telescopes, which give the unknown distance by observation of the apparent height of a man on foot or on horseback, placed near the distant point. None of these allow the estimation of distances greater than 1600 yards, and the results of observation are always uncertain. The *stadia* consists of a piece of sheet-metal with an isosceles triangle cut out of it, the sides of which are graduated parallel to its base; a slide moves along the length of the plate. The base of the opening is perpendicular to the sides of the instrument, and represents the apparent height of a man at a certain distance. The graduations may be determined by observation or by calculation, assuming a given height for the infantry or cavalry soldier.

Instruments constructed on the principal of the thread-telescope have been tried, but with little success for actual service, and especially have not been found sufficient for artillery-firing. During the last twenty years many instruments for measuring distances have been devised. Nearly all are concerned with the rapid solution of a triangle, one of whose sides is the distance to be determined, and another is a base of known length. The instruments of Goulier and Gautier, used in France, and that of Nolan, in England, are good examples. Of these, Gautier's has been experimented with in the United States. Gautier's telemeter is simple and portable, consisting of a tube, similar to one barrel of a field-glass, containing lenses and two mirrors placed at an angle of about 45 degrees with each other; but it requires an accurate base and delicate management. With practice, however, an observer can estimate with more than ordinary promptitude and precision the distance to be obtained. Nolan's range-finder consists of two instruments for measuring angles; they are mounted on tripods and are placed at the extremities of a measured base-line, which is perpendicular to the range. With the data thus obtained, recourse is had to a *reckoning-cylinder*, from which the distance is read. A base of from 30 to 40 yards will be used for ranges of 3000 yards and over. The Weldon range-finder, lately introduced, will, it is thought, prove a useful instrument for open ground. In this system are used a base, proportional to the sides of the triangle which converge on the object from the extremities of the base, and two simple plate-glass prisms, the angles of which are constructed accurately to have certain fixed values, and whose backs are silvered to act as mirrors. Two observers, each with a prism, place themselves on a line, the general direction of which is perpendicular to that of the object from them. Each then moves along this line till he brings the reflection of the object in the prism and the eye of the other observer, seen direct, in the same vertical line; the distance between the observers at this instant, multiplied by a certain factor, which depends on the angles of the prism, gives the distance of the object from either observer.

To estimate distances by the velocity with which sound is transmitted in the air, it is necessary to note the instant at which the flash of a gun or the explosion of a shell is seen, and the instant at which the report of the same is heard at the point of observation.

This is a simple and rapid method, but is not always accurate. A watch, or any instrument constructed to record time, can be employed. The *Le Boulengé telemeter* is such an instrument. It consists of a glass tube, filled with a non-freezing, transparent liquid; within this is a metal index, which, when the tube is vertical, descends with a slow, uniform motion. The tube is placed in a brass case, to which a scale is attached. The scale shows the distance, in yards, through which sound will travel in air during the time required for the index to descend to any division. The effect of temperature on the liquid and index is such that the velocity of the index is influenced in the same proportion as the velocity of sound, the instrument thus being self-adjusting. For pieces used in the siege and sea-coast services the ranges do not have to be determined under the same circumstances as in the field. The position of siege-batteries can be found at leisure, either from maps or by the instruments used ordinarily by surveyors. In the sea-coast service, the distance of a vessel can be determined by its position relative to known points on land, or to buoys that have been carefully located for that purpose. A simple instrument for taking horizontal angles, or any of those that are applied in the field, can be employed. The *plane-table* may be used advantageously for recording the striking-point of a shot or the position of a vessel. The tables are placed at each end of a base-line, so taken that the tables shall have a clear view of the object, of each other, and of the gun; the lines joining them with the object should intersect at as near a right angle as possible. The gun may be at any point of the base-line, or entirely without it. The distance can be calculated from the data obtained, or the object may be plotted and the distance measured by a scale.



Any of the following methods may be employed to estimate the breadth of a river, or any impassable distance, without instruments: 1st. Assume *dc* in any direction, and make *bc* = *bd* (*ab* being as nearly perpendicular to the banks as practicable); then, locating *e* on *ac* produced, make *bf* = *be*; join *f* and *d* and prolong *fd* to *ab* at *g*; then *bg* = *ab*. 2d. Produce *be* until the angle *bea* = 45°; then *be* = *ab*. 3d. Without reference to figure, the following methods may be used according to the location of the distance to be measured with respect to the surrounding country. (*a*) Let AB equal the distance to be measured. Produce AB to any point, D, and bisect BD in C. Through D draw D*a*, making an angle with DA, and take D*c* and D*b* = DC and DB respectively. Join B*c*, C*b*, and A*b*. Through E, the intersection of B*c* and C*b*, draw DEF, meeting A*b* in F. Join BF, which being produced will meet D*a* in *a*; then *ab* = AB. (*b*) From any point, C, draw any line *c*C and bisect it in D; take any point, E, in the prolongation of AC and draw the line E*e*, making D*e* = DE. In like manner take any point, F, in the prolongation of BC, and make D*f* = DF. Produce AD and *ec* till they meet in *b*; then A*b* = AB. (*c*) At any point, E, in AB drop a perpendicular and on it make E*b* = 50 feet, and EF = 60 feet. Trace a line through F perpendicular to EF. Then plant pickets at M and N, so that M, G, and B will be in the same right line; as also the points N, G, and A. Measure the distance (*d*) between M and N, then the distance required equals 5*d*.

ESTOC.—The long narrow sword intended for thrusting rather than cutting. The expression *frapper d'estoc et de taille* can only apply to the long broad-bladed sword, inasmuch as the blade of the rapier was suitable only for thrusts. The rapiers of the estoc shape were not in use before the reign of Charles V., in whose time the modern art of fencing seems to have originated. The estoc in Elizabethan times was generally called a *tucke*.

ESTOILE.—In Heraldry, a term differing from the mullet by having six waved points; the mullet consisting of five plain points. See *Heraldry*.

ESTRADIOTS.—Grecian and Albanian horsemen, some of whom were employed in the Italian wars by Charles VIII.; their favorite weapon was the zagaie. Besides this they had a broad-sword and club slung on the bow of the saddle, with sleeves and gauntlets of mail. Also written *Stradiots*.

ESTRAMACON.—A sort of two-edged sword used in ancient times. The term also expresses a blow with the edge of a sword.

ETAPPEN.—A Department which originated in the Prussian Military Railway Organization, and which was first formed in 1867, and revised in 1869; subsequently certain changes were made during the war of 1870–71. The object of this Department is to relieve the Commander-in-Chief and Field Army of all responsibility for their communications in the rear. Etappen Commissions a reappointed to each loading and unloading station, to which a Field Officer as Commandant, an Adjutant, Control Officer, Railway Officials, and Civil Government Officials, are attached. These officers supervise all local arrangements for loading or unloading, forwarding, feeding, billeting, etc. One of the officers originally appointed to this Department was an Inspector of Etappen; he was supposed to be a march in rear of headquarters, superintending all necessary arrangements, but he had no authority over the Civil Departments with which he came into contact. In 1870 the Inspector was found to have too much to do, and a considerable amount of friction ensued. The Commissariat Officer attached received orders from an Inspector and from his own Chief. The Railway Subordinate was liable to some ten different Chiefs, and the whole railway arrangements were half military, half civil. New regulations were subsequently introduced which extended the powers of the Inspector of Etappen. The official title is "Inspector of Etappen and Railways." He is present with headquarters, and under him are placed the Medical Department, Commissariat, Post-office, and Telegraphs, under responsible heads. The general principle or idea is this: A line is imagined to be drawn through the headquarters. All in front belongs to the active army, all in rear to the Etappen Inspector. The Quartermaster General's Department has to do with both. To take in the whole of the Prussian Railway Control ,it would be necessary to describe in full the system pursued, which space will not admit. An Étappen Department has been raised in the French army after the Prussian system.

ETAT MAJOR.—The Staff of an army, including all officers above the rank of Colonel; also, all Adjutants, Inspectors, Quartermasters, Commissaries, Engineers, Ordnance Officers, Paymasters, Surgeons, Signal Officers, Judge Advocates; also, the non-commissioned assistants of the above officers.

ETOILES.—Small redoubts which are constructed by means of angles rentrant and angles sortant, and have from 5 to 8 salient points. This species of fortification has fallen into disuse, and is superseded by square redoubts, which are sooner built and are applicable to the same purpose of defense.

ETOUPILLE.—An inflammable match, composed of three threads of very fine cotton, which is well steeped in brandy mixed with the best priming gunpowder.


EUROPE
SCALE OF MILES
0 100 200 300 400 500
ATLANTIC OCEAN
ARCTIC OCEAN
BRITISH ISLES
ICELAND
SCANDINAVIA
NORWAY
SWEDEN
NORTH SEA
BALTIC SEA
BAY OF BISCAY
LONDON
PARIS
FRANCE
SPAIN
PORTUGAL
GERMANY
AUSTRO-HUNGARY
ITALY
TURKEY
GREECE
RUSSIA
Finland
Poland
ST. PETERSBURG
Moscow
BLACK SEA
Sea of Azof
CASPIAN SEA
Georgia
MEDITERRANEAN SEA
MOROCCO
ALGERIA
TUNIS
AFRICA
TURKEY IN ASIA
Asia Minor
Armenia
PERSIA
SYRIA
Damascus
Jerusalem
Aleppo
Smyrna
CYPRUS (British)
CANDIA
BALEARIC ISLANDS
CORSICA
SARDINIA
Tripoli
G. of Sidra
Alexandria
Port Said
Longitude West
Longitude East of Greenwich

EUPHORBIA TIRUCALLI. — This plant is much used in making hedges in India. It is an evergreen. The wood makes very fair charcoal for gunpowder purposes, but it is not equal to that derived from the urhur or dhall-bush. In Bengali it is called *lunka sij*, and in Hindustani, *sendh*.

EUREKA PROJECTILE.—A projectile consisting of a cast-iron body in one piece, with a brass sabot; the sabot is an annular disk intended to move on the frustum of a cone with the expanding cup in rear to take the grooves. See *Projectiles*.

EUTHYTONE.—A very ancient machine of war, described by Heron, Philon, and Vitruvius. It was a variety of the catapult.

EVACUATE.—To withdraw from a town or fortress, in consequence either of a treaty or a capitulation, or of superior orders.

EVAGINATION.—A common expression for the unsheathing or drawing out of a sheath or scabbard.

EVANS MAGAZINE-RIFLE.—A novel rifle of some merit, but no longer manufactured. It differed from most magazine-guns in having no spiral spring for the purpose of feeding the cartridges through and from the magazine to the breech-mechanism, and in having its magazine located in the stock of the arm. The magazine consisted of a cylinder of forged iron, running from the breech to the butt-plate; around the inner circle of this cylinder was affixed, in the form of a spiral, a flat wire of the proper conformation. Into this cylinder with its fixed spiral was introduced a shaft of fluted or grooved iron, this shaft being revolved by movement of the lever in the breech-mechanism. The cartridges were introduced into the magazine through the butt-plate; with the introduction of each cartridge the breech-mechanism was moved, thus carrying forward the cartridges until the magazine was filled. The cartridges in the magazine were in separate cells, and could not come in contact with each other, thus precluding any possibility of discharge; while in all spiral-spring magazine-guns the cartridges press one against the other, thus rendering a premature discharge possible.

The system of feed in this gun strongly resembled the Archimedean screw. The magazine carried 26 rounds of cartridges of 2 inches in length, and could be loaded in one half of a minute, and the entire magazine of 26 rounds discharged at will, in from 15 to 20 seconds, thus embracing a very great repeating capacity. This arm could be fired 20 rounds per minute, while used as a single-loader, introducing the cartridges into an aperture at the side of the receiver at the breech; or it could be fired 20 rounds per minute, holding the magazine full and in reserve, by introducing cartridges into the magazine at the butt, as each cartridge was discharged. The weight of the gun was 9½ pounds, and length of barrel 30 inches. The carbine weighed 8½ pounds, and had a barrel 22 inches in length. See *Magazine-gun*.

EVENING PARADE.—The daily parade at or about sunset. When troops are encamped, the signal for evening parade is given from the park of artillery, by the discharge of a piece of ordnance, called the *evening* or *retreat gun*. See *Dress Parade*.

EVIDENCE.—All that which makes clear, demonstrates, or ascertains the truth of the very fact or point in issue. Evidence may be considered with reference to (1) the *nature* of the evidence; (2) the *object* of the evidence; (3) the *instruments* of evidence; and (4) the *effect* of evidence. As to its *nature*, evidence may be considered with reference to its being (1) the primary evidence; (2) secondary evidence; (3) positive; (4) presumptive; (5) hearsay; and (6) admissions. 1. *Primary evidence*. The law generally requires that the best evidence the case admits of shall be produced. 2. *Secondary evidence* is that species of proof which may be admissible on the loss of primary evidence. Before it is admitted, proof must be made of the loss or impossibility of obtaining the primary evidence. 3. *Positive evidence* is that which, if believed, establishes the truth of a fact in issue, and does not arise from any presumption. Evidence is positive when the very facts in dispute are communicated by those who have actual knowledge of them by means of their senses. 4. *Presumptive evidence* is that which is not direct, but where, on the contrary, a fact which is not positively known is presumed from one or more other facts or circumstances which are known. 5. *Hearsay* is the evidence of those who relate not what they know themselves, but what they have heard from others. As a general rule, hearsay evidence of a fact is not admissible. But evidence given on a former trial by a person since dead is admissible, as is also the dying declaration of a person who has received a mortal injury. 6. *Admissions*, which are the declarations made by a party for himself or those acting under his authority. These admissions are generally evidence of facts declared, but the admissions themselves must be proved.

The *object* of evidence is to ascertain the truth between the parties. Experience shows that this is best done by the following rules, which are now binding in the law: 1. The evidence must be confined to the point in issue; 2. The substance of the issue must be proved, but only the substance is required to be proved; 3. The affirmative of the issue must be proved. A witness, on being admitted in Court, is first subjected to the examination of the party in whose behalf he is called. This is termed the *examination in chief*. The principal rule to be observed by the party examining is that leading questions are not to be asked. The witness is then cross-examined by the other party. The object of cross-examination is twofold: to weaken the evidence given by the witness as to the fact in question, either by eliciting contradictions or new explanatory facts; or, secondly, to invalidate the general credit of the witness. In the latter case it is a general rule that a witness may refuse to answer any question if his answer will expose him to criminal liability. The general practice of English Courts also seems to authorize his refusal to answer any question which will disgrace him. The credit of a witness may likewise be impeached by the general evidence of others as to his character; but in this case no evidence can be given of particular facts which militate against his general credit. Witnesses are excluded from giving evidence by: 1. Want of reason or understanding; 2. Want of belief in God and a future state; 3. Infancy; 4. Interest. Besides witnesses, records and private writings are also *instruments* of evidence.

Records, in all cases where the issue is *nul tiel reord*, are to be proved by an exemplification duly authenticated; that is, an attestation made by a proper officer, by which he certifies that a record is in due form of law, and that the person who certifies it is the officer appointed by law to do so. In other cases an examined copy, duly proved, will in general be evidence. Private writings are proved by producing the attesting witness, or, in case of his absence, death, or other legal inability to testify, as if, after attesting the paper, he becomes infamous, his handwriting may be proved. When there is no witness to the instrument, it may be proved by evidence of the handwriting of the party, by a person who has seen him write, or in a course of correspondence has become acquainted with his hand. Parol evidence is admissible to defeat a written instrument on the ground of fraud, mistake, etc., or to apply it to its proper subject matter, or, in some instances, as ancillary to such application, to explain the meaning of doubtful terms, or rebut presumptions arising extrinsically. But in all cases the parol evidence does not usurp the place or arrogate the authority of the written instrument.

EVOCATI.—A class of soldiers among the Romans who, after having served their full time in the army, entered as volunteers to accompany some favorite General. Hence they were likewise called *Emereti* and *Beneficarii*.

EVOCATION. — An old religious ceremony commonly observed among the Romans at the commencement of a siege, wherein they solemnly called upon the gods and goddesses of the place to forsake it and come over to them. When any place surrendered, they always took it for granted that their prayer had been heard.

EVOLUTIONS.—The movements of troops in order to change position. The object may be to maintain or sustain a post, to occupy a new post, to improve an attack, or to improve a defense. All such movements as marching, counter-marching, route-marching, changing front, forming line, facing, wheeling, making column or line, making echelon or square, defiling, deploying, etc., come under the general heading of evolutions. The word *maneuver* signifies also movements of troops or entire corps in war executed with general views; and by some writers it is confined to that signification, and the word *evolution* is made to designate the particular means, or the elements of maneuvers. Maneuvers, according to Bardin, are operations in war, whether really before an enemy or simulated on a field of exercise. Their precision and aptness depend upon the skill of the General; the intelligence of his Aides-de-Camp; upon the Chiefs of Battalions and their Adjutants, and the General Guides. Evolutions and maneuvers are, however, often applied in the same sense, and indeed it may well be questioned whether there be any propriety in retaining in books of instruction evolutions which are not used as maneuvers against an enemy. The vicious idea that tactical evolutions are not used in war is by no means uncommon, and has frequently caused the loss of battles. It is true that the number of maneuvers used in combats is limited, and that those which are needed can only be judiciously applied by keeping in view moral and physical requirements. The judicious tactician will, therefore, in war eschew deployments, which cause the soldier to turn his back towards an enemy; counter-marches; forming a battalion on the right or left by file into line, and some other movements suited only to parades. One of the most hazardous maneuvers is the formation of columns of great depth and deploying those columns when too near the enemy.

The column is an order of march and maneuver, rarely an order of battle. When beyond the range of cannon, and at a distance from the line of battle to be occupied, if the enemy approach and time permits, it is necessary to close in mass, in order to hold the troops in hand for all possible dispositions. So, in marches near the enemy the columns should march at half-distance, when roads permit, in order that they may be less elongated and all the troops be ready to act promptly. If surprised in this order by the necessity of forming immediately forward into line of battle, or, if without being under this pressing necessity, there is between us and the enemy ground admitting an easy march in line of battle, the column ought to execute forward into line, according to the principles of the tactics. This movement is more prompt and greatly better than closing column in mass in order to deploy afterward. In the first case troops only pass over one side of the triangle, whilst by massing the column to deploy afterward they must pass over two sides by a complicated maneuver, which is dangerous from the beginning. In general, it is necessary to shun as much as possible the deployment of great massed columns, for this movement is badly executed even in exercises. It can only be performed far from the enemy, and it is even there inconvenient. It should be renounced in all formations whose object is to take the enemy in flank or reverse, if he be sufficiently near to take measures to prevent success. In that case the formation of the close columns in mass upon the right or left into line of battle is a necessary maneuver. This movement, as Marshal Bugeaud suggests, is most important in war. It would have an influence upon battles by the simplicity and rapidity of its execution, and accidents of ground would often be found to conceal the movement from the enemy. It admits of an attack in echelons of battalions against an enemy being commenced as soon as one battalion or the half of a battalion has formed on the right or on the left of the line of the enemy. It also offers the advantage of giving to the line, with the greatest facility, every form that may be wished, and protecting the successive formations by a mass that may be disposed of at pleasure, whether at the extremity of the line to form square against cavalry, or to occupy in advance upon the right or left a commanding position, protecting the flanks of our line. When circumstances, then, compel a march in heavy mass, it is better to present to the enemy a flank of columns, in order to deploy them by formations on the right or on the left into line of battle. When a line has to pass over a great distance, it is commonly formed into columns of attack. The formation by company in column, in rear of the Grenadiers of each battalion, is preferred by Marshal Bugeaud, because it is thus easier to make good dispositions against cavalry. The Grenadiers of each battalion make a half-wheel, and each battalion, after being closed in mass, forms square. But neither the column by companies nor divisions should be used within range of cannon, whenever there is a possibility of marching in line of battle. It is time that the fact should be admitted that although the moral effect of the column may be considerable, yet this may be paralyzed by a little maneuvering on the part of the enemy's *line*, which would necessarily obtain great advantage from the superiority of its fire. Small columns, at distances of three battalions from each other marching under cover of the line, may render great services. They would be ready promptly to fill the holes made in the line of battle, and the best means of doing this would be to take the enemy in flank who had pierced them, whenever they could. It is desirable that these columns should each not exceed a half-battalion, and that they should be commanded by energetic officers.

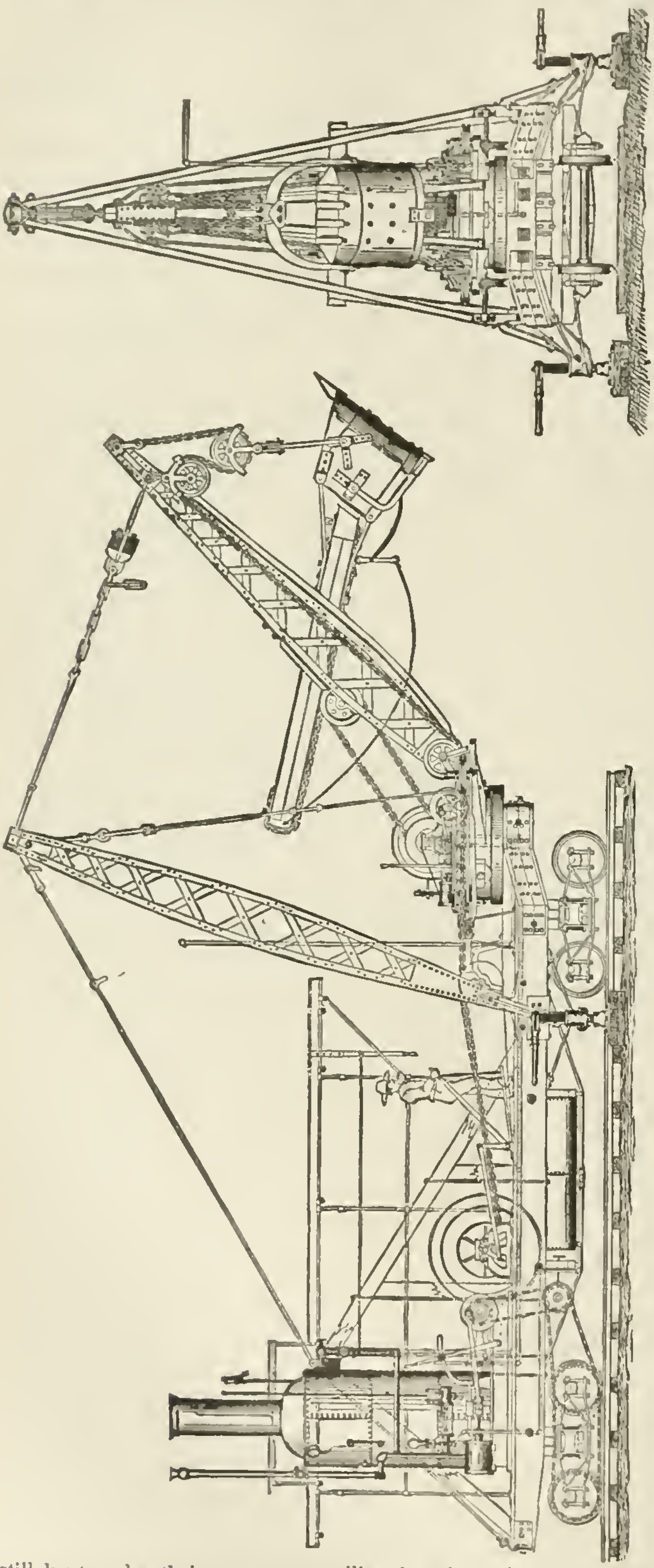
The depth of the column adds nothing to the strength of the first battalion composing it, and diminishes that of the mass. It is, then, vicious to employ more than one battalion, except in the small number of cases where it is necessary to fight in mass, as in carrying a bridge, a defile, an intrenchment, a breach, etc. The other battalions ought to follow at such a distance that they may sustain the attacking battalion without sharing in its disaster or rout, if such should take place. With an interval the Chiefs of Battalions have time to prepare their troops and make necessary dispositions; with a single mass the disorder at the head of the column is communicated to the rear almost as readily as an electric spark. Flank marches, in presence of the enemy, ought always to be made in open column. In this order we are always ready to fight by a simple wheel of each subdivision of the column. Nothing is deranged in the order of battle, whatever may be the strength and number of the lines. Without derangement an excellent disposition may also be made against cavalry. The column will be halted, and each battalion will be closed in mass upon its Grenadiers, who make a half-wheel. The Field-officers, Staff, and the officers of Grenadiers will be previously warned. Each battalion will form then Marshal Bugeaud's square. The first order will be resumed by taking distances by the head of each battalion; the Grenadiers retaking their direction at once. If deep columns are condemned as an order of attack, those barbarous columns employed in some of the last battles of Napoleon, and particularly at Waterloo, ought to be condemned still more. That column, which appeared to announce the decline of art, consisted in employing all the battalions of a division one behind the other, and thus marching towards the enemy. Every column has for its object to pass rapidly, and without confusion, into the order of battle, to pass over lightly a given space, and to make prompt dispositions against cavalry. The column against which these remarks are made does nothing of that kind, and if it be attacked upon its flanks, whether by cavalry or infantry, it cannot fail to be destroyed. The line of battle is the true order of battle. It is also the best order of march when in range of cannon and not exposed to cavalry. It is only in this order that infantry can make use of its fire. If battalions consist of 800 men they will, in a formation of two ranks, be too much extended for most Chiefs of Battalions. Two companies of each battalion ought then to be formed as columns of reserve. The order in two ranks is beyond question best suited, in oblique attacks, for that part of the line not to be engaged; and with rifle-muskets now used the two-rank formation will be found better for that part of the line which is, to strike also. Even with old muskets the two-rank formation was used by the British very successfully at Waterloo in squares against cavalry. The fire in two-rank formation is made with more order, more easily, and is better aimed. The march in line of battle ought to be employed whenever the ground permits it, within 1000 yards of the enemy. We lose then fewer men by cannon; and even if it be desirable to approach the enemy in column (which is very rare, and should even then be in columns of single battalions), the march ought still to be in line of battle until within two hundred yards, and then the column of attack ought to be formed while marching. Troops cannot be too much exercised in marching in line of battle. This march is no more difficult than the march of many heads of columns upon the same line, perhaps even less so, for it is difficult to maintain between the columns the intervals necessary for deployments.

Changes of front very near the enemy are rarely perpendicular. The new front nearly always forms with the line of battle an acute angle. In this case it is necessary to guard against breaking the battalions into column. It is better to use the changes of direction for the line of battle prescribed by the tactics. The two pivot battalions may be thrown upon the new line by companies half-faced to the right or left. The other battalions ought to be directed upon the new line by changes of direction which would least expose them to artillery. If, however, we have to guard against cavalry during the execution of the movement, it will be better to break into column the battalions of the leading wing. They will thus form the stem of the battery, and would rapidly make good dispositions against cavalry, as they would only be obliged to close in mass upon the Grenadiers and form square. Changes of front forward are possible under fire, but changes of front to the rear are not so. I believe, says Marshal Bugeaud, that the loss of one of our battles in Spain may, in great part, be attributed to a change of front in rear of the left wing, which was attempted at a moment when warmly engaged. The movement rapidly degenerated into a rout; and it could not be otherwise. There are no troops with sufficient *sang-froid* and self-possession to make that movement under the fire of ball and grape. To make the movement it is necessary first to stop the enemy, and the means of doing that vary with circumstances and the resources within our command. Charges of cavalry—above all if they threaten the flanks of the enemy's line—would cover the change of front to the rear. If cavalry be not at hand, there is no better means than to advance the second line to the position that it is desired that the front should occupy after its change of front, and withdraw the first line at a run, directing it to form the second line, passing through the intervals of the battalions, now become the first line. If a line is about coming up with the enemy at the moment of receiving the order to change front, it would be better to finish the charge, by putting the first line of the enemy in rout before executing the movement to the rear. This last principle is applicable to retreats generally: it is often necessary to overthrow an enemy who is too nigh before retiring. Running movements may, in many cases, save us from destruction. It is necessary, then, to exercise troops in such movements, and make them run in disorder, and re-form at some given point.

The *order in echelons* is the maneuver of oblique attacks. By that means we approximate those troops only who are to fight. The remainder are at once threatening and defensive. They hold in check one or many parts of the order of battle of the enemy, and present the best possible protection to the attacking portion. Some echelons to the right and left of that which attacks are greatly better than any other support. They render, if not impossible, at least very difficult an attack upon the flank of the attacking portion, as that cannot be assailed without the enemy in turn being taken in flank by echelons. And the latter cannot be turned except by strong movements, which must weaken the army executing them, and also afford necessary time to guard against them. Instead of placing flank brigades in advance of the front of the columns or lines that they protect, it is better to place them in rear. Besides the physical advantages of this disposition, there are moral advantages, inasmuch as the latter position enables the echelons to assail, whereas if they were immediately on the flank of the attack they might be assailed. In theory, echelons are placed at regular distances. In practice, the distance is determined by circumstances, and above all by the formation of the ground. The regularity of echelons can, therefore, only exist in broad plains. The greater or less distance between echelons depends upon the number of troops, the distances between those of the enemy, and the ulterior views of the General-in-Chief; but in general they ought to be within mutual succor, and if cavalry is to be repulsed, they ought to cross fire at about 150 paces after having formed square. The different movements of echelons, the changes of front in each echelon, with the same angle, are very useful in war; it is necessary, therefore, that troops should be exercised in such movements. See *Maneuvers*.

EXARCH.—The title first conferred by Justinian on his Commander-in Chief and the Vicegerent in Italy. The conquest of Italy by the Goths in the early part of the sixth century was a severe blow to the Byzantine pride; and Justinian determined to wipe out the disgrace and recover the imperial territories. The execution of this project was intrusted at first to Belisarius, and afterwards to Narses, by whom the reconquest of Italy was effected. The latter was the first who bore the title of Exarch; and the district over which he ruled was called the *Exarchate*. The seat of the Exarchs was Ravenna, the different towns and territories belonging to them being governed by subordinate rulers, styled *Duces* or Dukes. The extent of the Exarchate, however, was by degrees diminished, until it embraced only the country about Ravenna, the present Romagna, and the coasts of Rimini as far as Ancona. This was brought about partly by the conquests of the Longobards, partly by the Dukes of Venice and Naples making themselves independent. In the year 728 even this small portion fell, for a short time, into the hands of the Longobards. In 752 Astulf, or Astolphus, King of the Longobards, put an end to the Byzantine rule at Ravenna; but in 755 he was compelled to resign the Exarchate to Pepin the Less, King of the Franks, who gave it over to the Bishop of Rome, Stephanus II.—In the Christian Church Exarch was originally a title of the Bishops, afterward of a Bishop who presided over several others—a Primate. It was borne by the Bishops of Alexandria, Antioch, Ephesus, Cæsarea, and Constantinople, till it was finally exchanged for the title of Patriarch. A Superior over several monasteries was also called in ancient times an Exarch. The same title is also borne, in the modern Greek Church, by the person who "visits" officially, as a sort of Legate of the Patriarch, the clergy and churches in a Province.

EXAUCTORATIO.—In the Roman military discipline, this differed from the *missio*, which was a full discharge, and occurred after soldiers had served in the army 20 years; whereas the *exauctoratio* was only a partial discharge; they lost their pay, indeed, but still kept under their covers or vexilla, though not under the aquilla or eagle, which was the standard of the Legion; whence, instead of *Legionarii*, they were called *Subsignarii*, and were retained until they had either served their full time or had lands assigned them. The exauctoratio took place after they had served 17 years.



(End Elevation.)

Land-excavator used by Panama Canal Company.

(Side Elevation.)

EXCAVATOR.—A machine for digging earth and removing the same from holes. It is usually mounted on a carriage which traverses on a temporary track. At one end of the frame is a crane, which has a circular adjustment on its axial post. To the end of the chain-tackle is suspended a scoop made of boiler iron, whose lip is a steel edge with fingers. Direction is given to the scoop by means of a beam which may be called the scoop-handle, and when the scoop has been thrust by its weight into the earth, the beam affords a fulcrum on which the scoop rotates when the tackle-chain is wound up on the drum by the action of the steam-engine. The excavated earth along some parts of the line of the Suez Canal was transported by means of a pump. By the aid of a steam-pump water was mixed with the earth brought up by the dredge, and the mud so formed was spouted out upon both banks of the canal to such distance and in such quantities as to form high compact ramparts against the sand-showers blowing in from the desert. Ninety-six million cubic yards of earth have been thus taken out. The accompanying detailed drawings show the side and end elevations of a land-excavator such as is used by the Panama Canal Company, now engaged in carrying out M. de Lesseps' bold undertaking of constructing a canal across the Isthmus of Panama. This machine is built by the Osgood Dredge Company, Albany, N. Y., and is destined not only to revolutionize the past systems of excavating, but in consequence of its adaptability and effectiveness will play an important part in the construction of field and hasty fortifications. An examination of the drawing will show that the superiority of the design lies in the admirable distribution of the working strains, by which most of them are sent directly to the ground through the A-frame and jack-screws; in the placing of a spring in the boom-chain, thereby diminishing the shocks which would otherwise pass unimpeded to the A-frame, thus prolonging the life of the machine. The A-frame and boom are hinged, and can be lowered by steam-power on a platform-car, in front of the excavator; the machinery being mounted on a car of standard gauge, the excavator can then be put in any freight-train. The machines can also be used as wrecking or derrick cars. They are self-propelling. The dippers are made of *plate-steel* with *solid steel teeth* reaching nearly to the bottom of the dipper. The teeth are bolted on, and can readily be removed in order to have them sharpened. The sheave-shafts, stay-rod pins, etc., are of *steel.* The booms and A-frames are made of angle-iron, strongly braced, stayed, and riveted together. By means of the boom-chain, the boom can be adjusted to high or low lifts. A light iron framework with corrugated iron roof, or a wooden house, as may be preferred, shelters the engineer and fireman. Attached to the car is an iron tank for supplying the boiler with water. This is placed under the car and contains about 550 gallons. The fact that the machinery is mounted on a car having spring trucks is of great advantage to the life of the machine. These trucks give great elasticity and offer a favorable contrast to the rigidity of many of the ordinary steam-shovels. Again, the fact that the car has *eight* wheels gives to the machine a much larger bearing surface and gives less trouble in settling on the track, while it is at work, than does the ordinary steam-shovel. This point will be appreciated as one of great importance by any one who has had experience in the practical working of excavators. This is considered the best way to mount an excavator. In operation the weight is taken off the forward trucks by means of the jack-screws. Each jack-screw is supplied with a ratchet-wrench. The hoisting, the swinging, and the working of the dipper-handle are all accomplished through the agency of friction. There is no rack-and-pinion arrangement. The manner of construction—entirely different from that of the ordinary crane-machine—permits the use of a much larger power than could be put in a crane-excavator. The boom arrangement permits digging farther in advance of the machine than is possible with the crane-excavator. While this machine can make moves ahead of eight feet, the move ahead of the ordinary steam-shovel is only four feet. This excavator thus saves one half of the time occupied in moving. The speed of the machine in sand or gravel is three dippers per minute. In *hard material* it has a great superiority over crane-excavators, because of the great power and its being much more efficiently applied. For use in hard-pan the dipper is especially designed. The excavator has two independent pairs of engines. The main engines are for pulling the dipper through the bank and for swinging the turntable, which latter is accomplished by means of the independent friction-drums. On the turn-table is a pair of coupled engines which revolve with the turntable. They operate a drum around which winds a chain and, the chain being properly attached to the dipper-handle, run the handle out and in with great rapidity and ease. They hold the dipper to its work while the main engines are pulling it through the bank. These engines are supplied with steam through a universal joint, thus doing away with *flexible pipes*, which are liable to burst, to cause delay, and to scald the cranesman. The boilers are upright ones, of sufficient capacity for the work to be performed, and are made so that the cones and stacks can be taken off to enable the excavator to go under bridges. See *Dredging-machine.*

EXCHANGE OF PRISONERS.—Exchanges of prisoners take place, number for number, rank for rank, wounded for wounded, with added condition for added condition, such, for instance, as not to serve for a certain period.

In exchanging prisoners of war, such numbers of persons of inferior rank may be substituted as an equivalent for one of superior rank as may be agreed upon by cartel, which requires either the sanction of the Government or of the Commander of the Army in the field.

A prisoner of war is in honor bound truly to state to the captor his rank; and he is not to assume a lower rank than belongs to him in order to cause a more advantageous exchange, nor a higher rank for the purpose of obtaining better treatment. Offenses to the contrary have been justly punished by the Commanders of released prisoners, and may be good cause for refusing to release such prisoners.

The surplus number of prisoners of war remaining after an exchange has taken place is sometimes released either for the payment of a stipulated sum of money, or, in urgent cases, of provisions, clothing, or other necessaries. Such arrangement, however, requires the sanction of the highest authority.

The exchange of prisoners of war is an act of convenience to both belligerents. If no general cartel has been concluded, it cannot be demanded by either of them. No belligerent is obliged to exchange prisoners of war.

No exchange of prisoners should be made except after complete capture, and after an accurate account of them and a list of the captured officers has been taken. See *Cartel*, *Parole*, and *Prisoners of War.*

EXCHANGES.—Certain arrangements made between officers of the English army. An officer may exchange, or change places, in the Guards or Line, with another of equal rank in any regiment of the above Corps by mutual consent, and subject to the approval of the Minister of War, and on payment of a sum agreed upon between the officers. On the abolition of the system of purchasing commissions in 1871, the sum paid in effecting an exchange was limited to the actual cost thrown upon the officer exchanging. In view, however, of the general wish of the army, a bill was introduced into Parliament in 1874 (but was withdrawn as regards that session) to render again legal the payment of money as a bonus for exchanges. In the following year (1875) the bill, having been again brought forward, was passed. As each of the exchanging officers enters his new Corps at the bottom of his rank, exchange benefits officers who stick to their regiment by advancing them towards the top of the list, and therefore nearer to promotion. An officer on full pay may exchange with another on half pay, provided a younger life be not thereby added to the half-pay list, and subject always to the consent of the Secretary for War. Exchanges are ordinarily arranged by the Army Agents. See *Transfer.*

EXCUBIÆ.—In ancient warfare, the watches and guards kept in the day by the Roman soldiers. They differed from the *vigiliæ*, which were always kept in the night.

EXECUTION.—Military execution is the pillaging or plundering of a country by the enemy's army. It also means every kind of punishment inflicted in the army by the sentence of a Court-Martial, which is of various kinds, including putting a soldier to death by shooting him, which is the ordinary punishment of deserters to the enemy, mutineers, etc. This form of death is considered less disgraceful than hanging by the neck. In some rare instances blowing from the mouth of a gun has been resorted to.

EXECUTION OF LAWS.—On all occasions when the troops are employed in restoring or maintaining public order among their fellow-citizens, the use of arms, and particularly fire-arms, is obviously attended with loss of life or limb to private individuals; and for these consequences a military man may be called to stand at the bar of a Criminal Court. A private soldier also may occasionally be detached on special duty, with the necessity of exercising discretion as to the use of his arms; and in such cases he is responsible, like an officer, for the right use or exercise of such discretion. One of the earliest reported cases on this subject occurred in 1735, when Thomas Macadam, a Private Sentinel, and James Long, a Corporal, were tried before the Admiralty Court of Scotland, upon a charge of murder under the following circumstances: They were ordered to attend some customhouse officers, for their protection in making a legal seizure; and being in a boat with the officers in quest of the contraband goods, one Frazer and his companions came up with them, leaped into the boat, and endeavored to disarm the soldiers. In the scuffle the prisoners stabbed Frazer with their bayonets, and threw him into the sea. For this homicide the prisoners were tried and convicted of murder by a jury; and the Judge Admiral sentenced them to death.

But the High Court of Justiciary reversed this judgment, on the ground that the homicide in question was necessary for securing the execution of the trust committed to the prisoners. The report of this case contains the following remarks upon it by Mr. Forbes, afterwards Lord President of the Court of Session of Scotland; and they appear to be of great importance to military men: "Where a man has *by law* weapons put into his hands, to be employed not only in defense of his life when attacked, but in support of the execution of the laws, and in defense of the property of the Crown, and the liberty of any subject, he doubtless may use those weapons, not only when his own life is put so far in danger that he cannot probably escape without making use of them, but also when there is imminent danger that he may by violence be disabled to execute his trust, without resorting to the use of those weapons; but when the life of the officer is exposed to no danger, when his duty does not necessarily call upon him for the execution of his trust, or for the preservation of the property of the Crown, or the preservation of the property or liberty of the subject, to make use of mortal weapons, which may destroy His Majesty's subjects, especially numbers of them who may be innocent, it is impossible from the resolution of the Court of Justiciary to expect any countenance to, or shelter for, the inhuman act." This quotation, in the latter part of it, has a direct bearing on the case of the unfortunate Captain Porteus, whose trial took place in the following year, and whose melancholy fate is the groundwork of Sir Walter Scott's *Heart of Mid-Lothian.* In the year 1736 the Collector of Customs on the coast of Fife made a seizure of contraband goods of considerable value, which were condemned and sold. Two of the proprietors of these goods took an opportunity of robbing the Collector of just so much money as these goods had sold for. They regarded this as merely a fair reprisal and no robbery; but they were nevertheless taken up, tried, and condemned to death for the fact. With the exception of some smuggling transactions, in which they had been concerned, the prisoners were men of fair character; and the mob expressed much dissatisfaction with their sentence and the prospect of their execution. On the Sunday preceding the day appointed for the execution, the prisoners were taken to a church near the jail, attended by only three or four of the City Guards, to hear divine service. None of the congregation had assembled, and the guards being feeble old men, one of the prisoners made a spring over the pew where they sat, while the other, whose name was Wilson, in order to facilitate his companion's escape, caught hold of two of the guards with his hands, and seized another with his teeth, and thus enabled his companion to join the mob outside, who bore him off to a place of safety. Wilson then composedly resumed his own seat, without making any attempt to recover his own liberty. This generous conduct of Wilson created a strong public feeling in his favor; and the Magistrates of Edinburgh soon learned that an attempt would be made by the mob to rescue him at the place of execution. They therefore procured some of the regular forces on duty in the suburbs to be posted at a convenient distance from the spot, so as to support the City Guard, in case they should be vigorously attacked. The officer whose turn it was to do duty as Captain of the City Guard being deemed unfit for the critical duties of the day, Captain Porteus, unfortunately for himself, was appointed to the command on the occasion. His men were served with ball-cartridge; and, by order of the Magistrates, they loaded their pieces when they went upon duty. The execution took place without any disturbance until the time arrived for cutting down the body, when the mob severely pelted the executioner with stones, which hit the guards as they surrounded the scaffold, and provoked them to fire upon the crowd. Some persons at a distance from the place of execution were thus killed. As soon as the body was removed, Captain Porteus withdrew his men, and marched up the West Bow, which is a narrow winding passage. The mob, having recovered from the fright occasioned by the previous firing, followed the guard up this passage, and pelted the rear with stones, which the guards returned with some dropping shot, whereby some were killed and others wounded. On reaching the guard-house they deposited their arms in the usual form, and Captain Porteus went with his piece in his hand to the Spread Eagle Tavern, where the Magistrates were assembled. On his arrival there, he was charged with the murder of the persons who had been slain by the City Guards, on the allegation that he had commanded the guards to fire. The mob was very riotous, and called for justice upon him; and the Magistrates, after adjourning to the Council Chamber, committed him to the Tolbooth for trial. The strongest feeling existed against him on the part of the mob, until the hour of his trial before the High Court of Justiciary arrived, when, to their great satisfaction, he was found guilty, and condemned to be hanged. The higher classes of society, however, unaffected by the popular prejudice against the unfortunate prisoner, exerted themselves strenuously in his behalf, and succeeded in obtaining a reprieve. This created the greatest discontent among the lower orders, who, on the night before the day originally appointed for the execution, broke open the jail, dragged the unhappy Captain Porteus downstairs by the heels, carried him to the common place of execution, and there, throwing a rope over a dyer's pole, executed him with many marks of barbarity. The perpetrators of this outrage were never discovered, and the subject gave rise to very warm debates in Parliament, particularly in the House of Lords, with respect to the conduct of the City Magistrates and Officers. It was quite clear, however, with reference to the criminality of Captain Porteus, that he had ordered his men to fire without sufficient cause or justification; and, under such circumstances, he was in point of the law justly found guilty of murder.

Ensign Hugh Maxwell, of the Lanarkshire Militia, was tried in 1807, before the High Court of Justiciary of Scotland, for the murder of Charles Cottier, a French prisoner of war at Greenlaw, by improperly ordering John Gow, a Private Sentinel, to fire into the room where Cottier and other prisoners were confined, and so causing him to be mortally wounded. It appeared that Ensign Maxwell had been appointed to the military guard over 300 prisoners of war, chiefly taken from French privateers. The building in which they were confined was of no great strength, and afforded some possibilities of escape. The prisoners were of a very turbulent character, and to prevent their escape during the long winter nights an order was given that all lights in the prison should be put out by nine o'clock, and that if this was not done at the second call the guard were to fire upon the prisoners, who were often warned that this would be the consequence of disobedience with regard to the lights. On the night in question there was a tumult in the prison, but of no great importance; and Ensign Maxwell's attention having been on that account drawn to the prisoners, he observed a light burning beyond the appointed hour, and twice ordered it to be put out. This order not being obeyed, he ordered the sentry to fire, but the musket merely snapped. He repeated the order; the sentinel fired again, and Cottier received his mortal wound. At this time there was no symptom of disorder in the prison, and the prisoners were all in bed. The general instructions issued from the Adjutant General's Office in Edinburgh, for the conduct of the troops guarding the prison, contained no such order as that which Ensign Maxwell had acted upon; and it appeared that the order in question was a mere verbal one, which had from time to time, in the hearing of the officers, been repeated by the Corporal to the sentries, on mounting guard, and had never been countermanded by those officers, who were also senior to Ensign Maxwell. The Lord Justice Clerk described the case to the jury as altogether the most distressing that any Court had ever been called upon to consider, and laid it down most distinctly that Ensign Maxwell could only defend himself by proving specific orders, which he was bound to obey without discretion; or by showing that in the general discharge of his duty he was placed in circumstances which gave him discretion and called upon him to do what he did. His Lordship was of opinion that both these grounds of defense failed in the present case; and the jury having found Ensign Maxwell guilty of the minor offense of *culpable homicide*, with a recommendation to mercy, the Court sentenced him to nine months' imprisonment. Ensign Maxwell's conduct certainly exhibited none of those gross features which characterize murder; but at the same time he was guilty of a rash and inconsiderate act, which, if he had not been engaged at the time in military duty, though he was mistaken in the exercise of it, would probably have been held to amount to murder. In Maxwell's case, the soldier who fired the shot was not prosecuted for the act, nor was he liable to such prosecution.

It is laid down that if a ship's sentinel shoot a man because he persists in approaching the ship when he has been ordered not to do so, it will be murder, unless such an act was necessary for the ship's safety. And it will be murder, though the sentinel had orders to prevent the approach of any boats, had ammunition given to him when he was put on guard, and acted on the mistaken impression that it was his duty. In Rex *v.* Thomas, the prisoner was sentinel on board H.M.S. *Achille* when she was paying off. The orders to him from the preceding sentinel were to keep off all boats, unless they had officers in uniform in them, or unless the officer on deck allowed them to approach; and he received a musket, three blank cartridges, and three balls. The boats pressed, upon which he repeatedly called to them to keep off; but one of them persisted, and came close under the ship, and he then fired at a man in the boat and killed him. It was put to the jury to find whether the sentinel did not fire under the mistaken impression that it was his duty; and they found that he did. But the case being reserved for the opinion of the Judges, their Lordships were unanimous that it was murder. They thought it, however, a proper case for a pardon; and further, they were of opinion that if the act had been necessary for the preservation of the ship, as if the deceased had been mutinous, the sentinel would have been justified.

The several cases already cited turned upon the improper exercise of discretion by the officers concerned. But in the following case, though not attended with actual consequences involving a criminal charge, the discretion in the use of arms was wisely exercised, and indicated great presence of mind and correctness of judgment. Some years ago the public journals of London recorded the meritorious behavior of a Private Sentry, upon the occasion of a riotous mob assembled at the entrance of Downing Street, with the intention of attacking the Government Offices in that quarter of the town. This man standing alone presented his musket, and threatened to fire upon the crowd if the slightest attempt were made to approach the particular office for the defense of which he was placed on duty, and succeeded by the terror thus created, though at a great risk of consequences to himself, in keeping the rioters at bay until a larger force arrived to assist him. The soldier's conduct was publicly much approved. It was also clearly legal according to Macadam's case; and if after the announcement of his intentions the mob had pressed forward to execute their purpose, he would have been held justified at law in firing at the rioters upon his own responsibility. The Duke of Wellington, as Constable of the Tower, testified his marked approbation of this man's conduct, by promoting him at once to a Wardership at that fortress. During the Irish insurrection of 1848 Smith O'Brien was arrested at the railway station of Thurles, on a charge of high treason. A public passenger-train was on the point of starting for Dublin, and the engineer was mounted on the engine, with the steam up, and everything in readiness for the immediate prosecution of the journey. The scene of the arrest lay in the disturbed district, which was in the occupation of the troops employed to suppress the insurrection and prevent its extension. General Macdonald's Aide-de-Camp, having been apprised of the arrest, proceeded instantly to the station, and there commanded the engineer to dismount from the engine and to stop the train; it being of the utmost importance to the public safety and service that the news of the arrest should not be carried along the line of railway, as the country people might assemble in great numbers and destroy the rails, and rescue the prisoner, or otherwise impede the conveyance of the prisoner to Dublin. Such interference would obviously have occasioned great loss of life, besides the danger to the public service at such a season. The engineer at first refused to obey the Aide-de-Camp's orders, whereupon the officer presented his pistol at the engineer, and threatened him with instant death if he persisted in his refusal. The man then dismounted; but it is conceived that the officer pursued a correct line of conduct, and exercised upon the occasion a sound discretion, which would have been a good legal defense to him if he had ultimately proceeded to execute his threat upon the engineer. "Power in law" (says Sir Edward Coke) "means power with force." The right of officers or soldiers to interfere in quelling *a felonious riot*, whether with or without superior military orders, or the direction of a Civil Magistrate, is quite clear and beyond the possibility of mistake. This subject, however, was formerly little understood; and military men failed in their public duty through excess of caution.

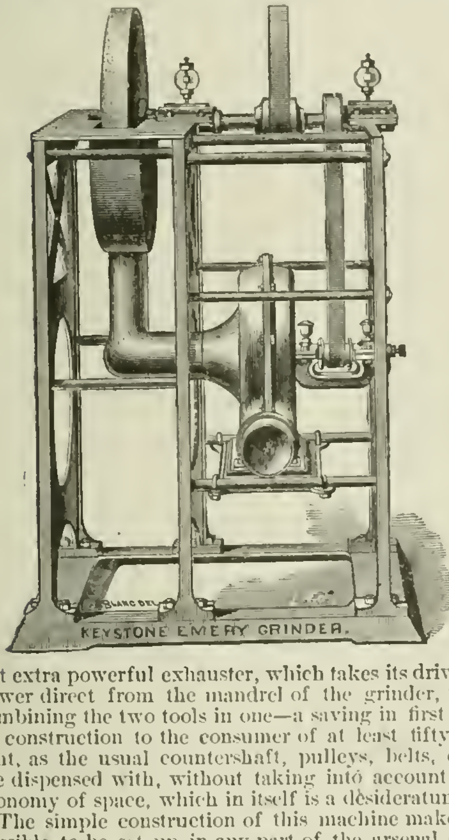
George III. and his Attorney General (Wedderburn) both deservedly acquired high credit for their energy in the crisis of the riots of 1780. When the King heard that the troops which had been marched in from all quarters were of no avail in restoring order, on account of a scruple that they could not be ordered to fire till an hour after the Riot Act had been read, he called a Cabinet Council, at which he himself presided, and propounded for their consideration the legality of this opinion. There was much hesitation among the Councilors, as they remembered the outcry that had been made by reason of some deaths from the interference of the military in Wilke's riots, and the eagerness with which Grand-juries had found indictments for murder against those who had acted under the command of their superiors. At last the question was put to the Attorney General, who attended as Assessor, and he gave a clear, unhesitating, and unqualified answer to the effect, that if the mob were committing a felony, as by burning down dwelling-houses, and could not be prevented from doing so by other means, the military, according to the law of England, might and ought to be ordered to fire upon them; the reading of the Riot Act being wholly unnecessary and nugatory under such circumstances. The exact words used by him on this occasion are not known; but they must have been nearly the same which he employed when he shortly afterwards expounded from the judgment-seat the true doctrine upon the subject. The requisite orders were issued to the troops, the conflagrations were stopped, and tranquillity was speedily restored. This eminent lawyer having become Chief Justice of the Court of Common Pleas, with the title of Lord Loughborough, delivered a charge to the Grand-jury on the special commission for the trial of the rioters of 1780, in the following terms: "I take this public opportunity of mentioning a fatal mistake into which many persons have fallen. It has been imagined, because the law allows an hour for the dispersion of a mob to whom the Riot Act has been read by the Magistrate, the better to support the civil authority, that during that time the civil power and the Magistracy are disarmed, and the King's subjects, whose duty it is at all times to suppress riots, are to remain quiet and passive. No such meaning was within view of the Legislature, nor does the operation of the Act warrant such effect. The Civil Magistrates are left in possession of all those powers which the law had given them before. If the mob collectively, or a part of it, or any individual within or before the expiration of that hour, attempts, or begins to perpetrate, an outrage amounting to felony, to pull down a house, or by any other act to violate the law, it is the duty of *all present*, of whatever description they may be, to endeavor to stop the mischief, and to apprehend the offender." "A riot" (says Mr. Justice Gaselee) "is not the less a riot, nor an illegal meeting, because the proclamation of the Riot Act has not been read; the effect of that proclamation being to make the parties guilty of a capital offense if they do not disperse within an hour; but if that proclamation be not read, the common-law offense remains, and it is a misdemeanor; and all Magistrates, Constables, and even private individuals are justified in dispersing the offenders; and if they cannot otherwise succeed in doing so, they may use force." After the suppression of the great riots of London in 1780 by the aid of the troops, as already mentioned, the Government was acrimoniously attacked both in and out of Parliament, on the ground that the employment of a military force, to quell riots by firing on the people, could only be justified, if at all, by martial law proclaimed under a special exercise of the royal prerogative; and it was thence argued that the nation was living under martial law. But Lord Mansfield, the Chief Justice of the King's Bench, addressed the House of Lords on this subject, and placed it in its true light. "I hold" (said his Lordship) "that His Majesty, in the orders he issued by the advice of his Ministers, acted perfectly and strictly according to the common law of the land and the principles of the Constitution. . . . . Every individual in his private capacity may lawfully interfere to suppress a riot, much more to prevent acts of felony, treason, and rebellion. Not only is he authorized to interfere for such a purpose, but it is his duty to do so; and if called upon by a Magistrate, he is punishable in case of refusal. What any single individual may lawfully do for the prevention of crime and preservation of the public peace may be done by any number assembled to perform their duty as good citizens. It is the peculiar business of all Constables to apprehend rioters, to endeavor to disperse all unlawful assemblies, and, in case of resistance, to attack, wound, nay, kill those who continue to resist; taking care not to commit unnecessary violence, or to abuse the power legally vested in them. Every one is justified in doing what is necessary for the faithful discharge of the duties annexed to his office, although he is doubly culpable if he wantonly commits an illegal act under the color or pretext of law. The persons who assisted in the suppression of those tumults are to be considered mere private individuals acting as duty required. My Lords, we have not been living under martial law, but under that law which it has long been my sacred function to administer. For any violation of that law the offenders are amenable to our ordinary Courts of Justice, and may be tried before a jury of their countrymen. Supposing a soldier or any other military person who acted in the course of the late riots had exceeded the power with which he was invested, I have not a single doubt that he may be punished, not by a Court-Martial, but upon an indictment to be found by the Grand Inquest of the City of London or the County of Middlesex, and disposed of before the ermined Judges sitting in Justice Hall at the Old Bailey. Consequently the idea is false that we are living under a military government, or that, since the commencement of the riots, any part of the laws or of the Constitution has been suspended or dispensed with. I believe that much mischief has arisen from a misconception of the Riot Act, which enacts that after proclamation made persons present at a riotous assembly shall depart to their homes; those who remain there above an hour afterwards shall be guilty of felony and liable to suffer death. From this it has been imagined that the military cannot act, whatever crimes may be committed in their sight, till an hour after such proclamation has been made, or, as it is termed, 'the Riot Act is read.' But the Riot Act only introduces a new offense—remaining an hour after the proclamation—without qualifying any pre-existing law, or abridging the means which before existed for preventing or punishing crimes."

It may, perhaps, be useful to subjoin a General Order issued to the Commander-in-Chief at Madras, in April, 1825, during the government of Sir Thomas Munro, shortly after a melancholy affair at Kittoor, in which one or two civil servants of the East India Company lost their lives under circumstances which, in the opinion of the public authorities, indicated, both in the civil and military functionaries, a want of general knowledge respecting the subject of the order: "The Honorable the Governor in Council deems it necessary to lay down the following rules relative to the exercise of the authority with which Civil Magistrates, and other officers acting in a similar capacity, are vested, for calling out military force to preserve the peace of the country: 1. The first and most important rule is, that no Civil Officer shall call out troops until he is convinced, by mature consideration of all the circumstances, that such a measure is necessary. 2. When the Civil Officer is satisfied of the necessity of the measure, he should, before carrying it into execution, receive the sanction of Government, unless the delay requisite for that purpose is likely to prove detrimental to the public interests. In that case, also, he should fully report the circumstances to Government. 3. When the Civil Officer may not deem it safe to wait for the orders of Government, he should address his requisition for troops, not to any subordinate military officer, but to the officer commanding the division, to whom he should communicate his object in making it, and all the information he may possess regarding the strength and designs of those by whom the public peace is menaced or disturbed. His duty is confined to these points. *He has no authority in directing military operations.* 4. The officer commanding the troops has alone authority to determine the number and nature of those to be employed, the time and manner of making the attack, and every other operation for the reduction of the enemy. 5. Whenever the officer commanding the division may think the troops at his disposal inadequate to the enterprise, he should call upon the officer commanding the neighboring division for aid, and report to Government and to the Commander-in-Chief. 6. No Assistant or Subordinate Magistrate is authorized to call out troops. When any such officer thinks military aid necessary, he must refer to his Superior, the Principal Magistrate of the district. The foregoing rules are to be observed when it can be done without danger to the public safety. Should any extraordinary case occur, which admits of no delay, civil and military officers must then act according to the emergency and the best of their judgment. Such cases, however, can rarely occur, unless when an enemy becomes the assailant; and therefore occasion can hardly ever arise for departing from the regular course of calling out troops, only by the requisition of the principal Civil Magistrates of the Province, to the officer commanding the division. Ordered, that the foregoing resolutions be published in General Orders to the army, and be communicated for the information and guidance of such Civil Officers as they concern." See *Posse Comitatus*.

EXEMPT.—A term variously applied in military matters. Men of certain age are exempt from serving in the militia. An Aide-de-Camp and Brigade Major are exempt from all regimental duties while serving in those capacities. Officers on Courts-Martial are sometimes exempt from all other duties until the Courts are dissolved.

EXERCISE.—Maneuvering bodies of men together. The drill of a mounted battery of artillery is termed *exercise*. All such use as the soldier is instructed in in the knowledge of his weapon is termed *exercise*, such as bayonet-exercise, firing-exercise, lance-exercise, manual, pistol, and sword exercise. See *Gymnastics*.

EXHAUSTER.—An apparatus used in connection with the emery-grinder and similar machines to carry off the emery-dust, shavings, etc. The value of this excellent machine is highly appreciated by those who have much work to perform at the emery-wheel. Emery-dust set free in a workshop is an intolerable nuisance, and destructive to fine machinery, even though this be situated in an adjoining room. It has caused serious inconvenience to the eyes as well as fatal injury to the lungs of the operator. In consequence these valuable, and now almost indispensable, assistants to the iron-worker are rejected by many who, if it were not so, would be glad to introduce them at once. To the grinder is attached a small



KEYSTONE EMERY GRINDER.

but extra powerful exhauster, which takes its driving-power direct from the mandrel of the grinder, thus combining the two tools in one—a saving in first cost of construction to the consumer of at least fifty per cent, as the usual countershaft, pulleys, belts, etc., are dispensed with, without taking into account the economy of space, which in itself is a desideratum.

The simple construction of this machine makes it possible to be set up in any part of the arsenal convenient to the driving-power. The refuse dust may be deposited into a small tank of water immediately in front of the table, or it may be conveyed out of the building, either at a window or through an ordinary chimney-flue. As every particle of dust is carried from the stone as fast as made, the eyes and respiratory organs of the workman will need no artificial protection. See *Emery-grinder*.

EXON.—In England, an officer of the Yeomen of the Royal Guard; an exempt.

EXOSTRE.—The bridge of the *helepole*, or movable tower of the ancients, by which they passed upon a wall during a siege.

EXPANDING PROJECTILES.—Projectiles of this class are forced to take the grooves by the action of the charge of powder, and require no other precaution in loading than spherical shell. It is essential, however, that the base-ring of every rifle-projectile, especially the Parrott, shall be greased before entering it into the gun, to prevent the formation of a hard deposit in the grooves. Parrott's projectile is composed of a cast-iron body and brass ring cast into a rabbet formed around its base. The ring is from 1 inch to 1¼ inch in width, and about 1 inch in maximum depth. The gas presses against the bottom of the ring and underneath it, so as to expand it into the grooves of the gun. To prevent the ring from turning in the rabbet, the latter is recessed at several points of its circumference, like the teeth of gearing. The diameter of the rabbet is greatest at the extreme rear of the shot, so that the brass ring cannot fly off without breaking. The entire projectile is slightly smaller than the bore, so as to be easily rammed home. The projectile has a slight groove turned out of the iron of the base to permit the powder gases to enter and expand the ring. The use of a little grease or other lubricating material on the base of the projectile, before firing, is advantageous. Parrott's shot for iron-clad fighting, as shown in the drawing, is entirely of cast-iron, but is reduced and chilled at the end, which prevents its mashing like strong soft cast-iron.

The new Parrott projectile differs from that just described in that the base is separated from the expanding ring by a *cannelure* which renders its taking the grooves more certain. Those for the 60-pounder and under have one hole for the core-stem, which becomes the fuse-hole. The larger projectiles have a hole in each end in consequence of the necessity of using two core-stems to steady the core. The battering-shell have but one hole in rear which serves as a loading-hole; the hole in rear is closed by a screw-plug. The Hotchkiss projectile is composed of three parts: the body, the expanding ring of lead, and the cast-iron cup. The action of the charge is to crowd the cup against the soft-metal ring, thereby expanding it into the rifling of the gun. The time-fuse projectile has deep longitudinal grooves cut on its sides to allow the flame to pass over and ignite the fuse. The last rifle-projectile submitted by Mr. Hotchkiss has an expanding cup of brass attached to its base in a very peculiar manner. The cup is divided into four parts by thin projections on the base of the projectile. This arrangement is intended to facilitate the expansion of the cup and to allow the flame to pass over to ignite the fuse.

The Butler shell also belongs to this class, and differs from the mode of attaching the expanding ring and in the position of the cannelure. The expanding ring is screwed on to the base, in such a manner that the rotary motion screws in tighter; the rear part is divided by the cannelure into two lips, so that the gases are distributed evenly and the entrance of the gas between the ring and the body of the projectile is prevented; the grip of the inner lip on the projectile being also increased by the wedging action of the gas. See *Arrick Projectile, Blakely Projectile, Butler Projectiles, Confederate Projectiles, Dana Projectile, Dyer Projectile, Hotchkiss Projectiles, James Projectile, Parrott Projectiles, Projectiles, Sawyer Projectiles*, and *Schenkle Projectile*.

EXPANSIVE SYSTEM OF RIFLING.—This system embraces all projectiles which in loading are inserted in the gun without respect to the rifling, but which take the grooves by the action of the gases of discharge upon a device or feature of the projectile, which is readily expanded thereby into the grooves of the gun. This class of projectiles has been so extensively and almost exclusively used in the United States that it is known as the American system. The chief projectiles of this class are: 1. Those where the sabot is of lead or soft metal. In these the windage is apt to be entirely closed. The lead may strip or be forced over the projectile, and balloting or wedging be induced. 2. Those having sabots of copper or brass, cup-shaped on the bottom of the projectile. These seem to suffer from the violence of the explosion within the cup, which is apt to be broken or unevenly set up. 3. Those where a leaden jacket is forced out by the action of the discharge upon a wedge or key. These have small capacity as shell and little strength as shot, strip easily, and are open to many objections. 4. Those where a concave or convex disk is flattened against the base of the projectile, or in addition is provided with a flange or key which is driven by the discharge upon the tapered base of the projectile. 5. Those where the rotating device consists of an annular band or ring attached to the base of the projectile and intended to be expanded into the rifling by the gases of discharge. These have proved most successful in practice. See *System of Rifling.*

EXPATRIATION.—A voluntary transfer of residence and allegiance from one's native land to another country and government. Despotic governments have assumed the right to forbid such a change on the part of their citizens, but the United States recognizes the right of the individual citizen, at his own pleasure, to leave the country of his birth and make his home in a foreign land. Naturalization, however, is necessary to the complete transfer of allegiance. The United States defends the rights and liberties of naturalized precisely as it does those of native citizens. A naturalized citizen of this country, visiting his native land, is protected by the American flag as though he had been born on American soil. Of course this right of expatriation cannot be made a cover for a previous breach of trust, or the commission of any crime, in the place of one's birth; but the assumption that the law of his native land requiring him at a certain time of his life to do military duty nullifies for the time being a man's right of expatriation is not allowed by the United States. Thousands of young men leave the Old World for the avowed purpose of avoiding military conscription, and the United States welcomes them to citizenship, with all its rights and obligations.

EXPEDITION.—The organization and march of a small army or body of men for hostile purposes. One of the principles of many small expeditions is surprise, which, if well carried out, will insure success. To the soldier, no part of his duty is so exciting and interesting as an expedition, for it implies risk, hazard, and danger, in which nature of warfare the enthusiastic and daring soldier delights.

EXPENSE-MAGAZINES.—The very small gunpowder-magazines, containing the made-up ammunition for the service of the guns on the works, at the rate of so many rounds per gun. In fortifications of the old construction an expense-magazine was made in each bastion and battery, though this was not always the case. Expense-magazines are often made under the earthen ramparts of fortifications, with a passage cut into them in the interior slopes. In the more modern works, such as the *Instruction of Fortification at the Royal Military Academy, Woolwich*, it is shown that expense-magazines should be placed as near as is practicable to the guns which they have to supply, and may often be conveniently constructed under the traverses and below the level of the terre-plein, with lifts of communication. They can, if so situated, be easily secured against the enemy's fire, and be provided with subterranean communications with the main magazine, which would permit them to be replenished without risk, even during action. The first suggestions made as to the size of expense-magazines in fortifications of the present day gave four guns to be supplied by each, but a later recommendation proposes only two guns, in the case of very heavy guns.

EXPERIMENTS.—The trials or applications of any kind of military machines in order to ascertain their practical qualities and uses.

EXPIRATION OF SERVICE.—The termination of a soldier's contract of enlistment, usually five years.

EXPLOSION.—The term *explosion* is rather loosely used. Considering it as synonymous with explosive reaction, it may be defined as a chemical action causing the sudden or extremely rapid formation of a very great volume of highly expanded gas.

Explosive effect is caused by the blow or impulse given by this rapid production of gas in a confined space. The explosive character of the change, then, depends—1st. Upon the great change of state produced; that is, the formation of gas very much greater in volume than the substance from which it is derived, and which is still more expanded by the heat evolved. 2d. Upon the shortness of the time required for the change to take place. Both these causes operate to a greater or less extent in all explosive reactions. When both are fully exerted the most energetic chemical reaction, or, in other words, the most violent explosion, takes place. Also, the differences in explosions and explosive bodies depend upon the differing manner and proportions in which they are exerted. Thus, nitro-glycerine is much more powerful and violent than gunpowder, because it generates a larger volume of gas in a shorter time. Again, fulminating mercury is not more powerful than gunpowder, although the decomposition goes on more quickly, since the quantity of gas given off and the temperature of the reaction are less.

The kinds and quantity of gas given off in an explosive reaction depend upon the chemical composition of the explosive body and the character of the decomposition. The heat evolved during the reaction adds to the effect by increasing the tension (expanding the volume) of the gas formed. The heat given off in a reaction is an absolute quantity, the same whether the reaction goes on slowly or rapidly. But the *explosive* effect will evidently greatly depend upon the *rapidity* of the formation and expansion of the gas. Thus, if an explosive undergoes the same change under all circumstances of firing, then the total amount of force developed will always be the same; but the *explosive effect* will be increased as the time of action is lessened. Explosions are greatly affected by the circumstances attending them. Different substances, of course, give different results, from their different compositions and reactions. But we also find that the same substance will exercise a different explosive effect when fired under certain conditions than under others. These may affect either the rapidity or the results of the chemical change. By shortening the time of the reaction the explosion is rendered sharper and more violent. With some explosives the decomposition is different under different circumstances. Thus, gunpowder when fired under great pressure gives different products than when fired unconfined. Circumstances of explosion may be generally considered under—1st. Physical or mechanical condition of the explosive body itself. 2d. External conditions. 3d. Mode of firing. Many instances may be given indicating the influence of its state upon the explosion of a substance. Thus, nitro-glycerine at temperatures above 40° Fahr. is a liquid, and in a liquid condition may be violently exploded by a fuse containing 15 grains of fulminating mercury. Below 40° it freezes and cannot be so fired. The advantage of dynamite over nitro-glycerine lies altogether in the fact that the former is presented in another mechanical condition, more convenient and safer to use than the liquid form. The nitro-glycerine itself is the same chemically in either case. The same mixture of charcoal, sulphur, and saltpeter gives a very different effect if made up into large grains than if made up into small ones. Gun-cotton presents the most marked example of the effect of mechanical state, since it can be prepared in so many ways. If flame is applied to loose uncompressed gun-cotton it will flash off; if it is spun into threads or woven into webs, its rate of combustion may be so much reduced that it can be used in gunnery or for a quick fuse; powerfully compressed and damp, it burns slowly; dry gun-cotton may be exploded by a fulminate-fuse; wet, it requires an initial explosion of a small amount of dry, etc.

Confinement is necessary to obtain the full effect of all explosives. The most rapid explosion requires a certain time for its accomplishment. As the time required is less, the amount of confinement necessary is less. Then, with the sudden or violent explosives, the confinement required may be so small that its consideration may be practically neglected. For instance, large stones or blocks of iron may be broken by the explosion of nitro-glycerine upon their surfaces in the open air. Here the atmosphere itself acts as a confining agent. The explosion of the nitro-glycerine is so sudden that the air is not at once moved. Again, chloride of nitrogen is one of the most sudden and violent of all explosives. In its preparation it is precipitated from a watery liquid, and therefore is, when used, wet or covered with a very thin film of water. This thin film of water, not more than $\frac{1}{1000}$ of an inch in thickness, is a necessary and sufficient confinement, and if it is removed the explosive effect is much diminished. Gunpowder, on the other hand, requires strong confinement, since its explosion is comparatively slow. Thus, in firing a large charge of gunpowder under water, unless the case is strong enough to retain the gases until the action has become general, it will be broken, and a large amount of the powder thrown out unburned. This is often the case in firing large-grained powder in heavy guns. The ball leaves the gun before all the powder has burned, and grains or lumps of it are thrown out uninjured. The confinement needed by the slower explosives may be diminished by igniting the charge at many points, so that less time is required for its complete explosion.

In any explosive reaction the mode of bringing about the change exercises an important influence. The application of heat, directly or indirectly, is the principal means of causing an explosion. Thus, in gunnery, the flame from the percussion-cap or primer directly ignites the charge; so also a fine platinum wire heated by an electric current will ignite explosive material which is in contact with it. Friction, percussion, concussion, produce the same effect indirectly, by the conversion of mechanical energy into heat, which is communicated to the body to be exploded. When one explosive body is used as a means of firing another, it may be considered that the blow delivered by the gas suddenly formed from the firing-charge acts percussively upon the mass to be exploded. The particles of this gas are thrown out with great velocity; but meeting with the resistance of the mass around them, they are checked, and their energy is converted into heat. It is found, however, that the action of explosives on one another cannot be perfectly explained in this way. If the action were simply the conversion of energy into heat, then the most powerful explosive would be the best agent for causing explosion. But this is not the case. Nitro-glycerine is much more powerful than fulminating mercury; but 15 grains of the latter will explode gun-cotton, while 70 times as much nitro-glycerine will not do it. Chloride of nitrogen is much more violent than fulminating mercury, but larger quantities of the former than of the latter must be used to cause other explosions. Again, nitro-glycerine is fired with certainty by a small amount of fulminating mercury, while with a much larger amount of gunpowder the explosion is less certain and feebler. In these cases it is evident that the fulminating mercury must have some special advantage, since it produces the desired effect more easily than the others. It may be considered that the fulminating mercury sets up a form of motion or vibration to which the other bodies are sensitive. Just as a vibrating body will induce corresponding vibrations in others, so the peculiar rate of motion or wave of impulse sent out by the fulminating mercury exerts a greater disturbing influence upon the molecules of some bodies than that derived from other substances.

An explosive molecule is unstable and very susceptible to external influences. Its atoms are in a nicely balanced equilibrium, which is, however, more readily overturned by one kind of blow than another. The explosive molecule takes up the wave of impulse of the fulminate, but the strain is too great, and its own balance is destroyed. So a glass may stand a strong blow; while a particular note or vibration will break it. In the case mentioned above, of gun-cotton affected by nitro-glycerine or fulminate, the explosion of the nitro-glycerine is strong enough to tear and scatter the gun-cotton, but the blow, though very powerful, is not one that the gun-cotton is sensitive to; on the other hand, the fulminate blow, though weaker, readily upsets the molecule of the gun-cotton. In addition, the explosion proceeds very differently when brought about in this way than when caused by simple inflammation. When a mass of explosive is ignited by a flame, the action extends gradually through it; but if it is exploded by a blow, acting in the manner above described, it is plain that the explosion will be nearly instantaneous throughout, since the impulse will be transmitted through the mass with far greater rapidity than an inflammation proceeding from particle to particle. The explosive reaction will then proceed much more rapidly, and the explosive effect will be more violent.

The phenomenon of the explosion of powder may be divided into three distinct parts, viz., *ignition*, *inflammation*, and *combustion*. By ignition is understood the setting on fire of a particular point of the charge; by inflammation, the spread of the ignition from one grain to another; and by combustion, the burning of each grain from its surface to center. See *Combustion*, *Detonation*, *Explosive Agents*, *Gunpowder*, *Ignition*, and *Inflammation*.

EXPLOSIVE AGENTS.—There is some question as to the influence, direct or indirect, upon modern civilization of the introduction of explosive agents for the purpose of war. Some eminent authors have gone so far as to consider the invention of gunpowder as next in importance, in its ultimate effects, to those of printing and the application of steam-power. However this may be, it is well to remember that explosive substances are now of immense utility in the arts of peace; indeed, it is not too much to say that without their aid many of the great engineering enterprises of the present day would either be impossible, or else have to be carried out at a vast additional expenditure of time and labor. The germ of all the knowledge which we possess of explosive reaction undoubtedly lay in the probably accidental discovery, many years ago, of the deflagrating properties of the natural substance niter or saltpeter (KNO_3), when in contact with incandescent charcoal. By distilling niter with oil of vitriol the alchemists obtained a corrosive fluid which they called *aquafortis*, now known as nitric acid (HNO_3), which parts with its oxygen even more rapidly than saltpeter; so that if the strongest nitric acid be poured upon finely powdered charcoal, the latter takes fire at the ordinary temperature. Somewhat less than half a century back it was discovered by some French chemists that upon treating various organic substances, such as starch, the sugars, cotton fabrics, and even paper, with concentrated nitric acid under proper precautions, the chemical constitution of the substances underwent a great change, and they became endowed with violently explosive properties, while remaining for the most part unaltered in external characteristics. To this discovery we owe a distinct class of explosive compounds, the most powerful for practical purposes as yet known. Examining into those principles of constitution and action which are more or less common to all explosive substances, we may define, for our purpose, the term "explosive" as the sudden or extremely rapid conversion of a solid or liquid body of small bulk into gas or vapor, occupying very many times the volume of the original substance, and, in addition, highly expanded by the heat generated during the transformation. This sudden or very rapid expansion of volume is attended by an exhibition of force more or less violent according to the constitution of the original substance and the circumstances of explosion. Any substance capable of undergoing such a change upon the application of heat or other disturbing cause is called an explosive agent. The most explosive substances that are practically the most important essentially contain carbon, oxygen, and nitrogen, the last always existing in a state of feeble combination with the whole or part of the oxygen, and thus creating that condition of unstable chemical equilibrium which is necessary. When explosion takes place the nitrogen parts with its oxygen to the carbon, for which it has a greater affinity, forming carbonic acid (CO_2) and carbonic oxide (CO) gases, the combination being accompanied with great generation of heat, and the nitrogen being set free. In most explosives there is also hydrogen accompanying the carbon, and by its combustion producing an extremely high temperature: it combines with part of the oxygen to form water in the form of greatly expanded vapor. Other subordinate elements are often present; in gunpowder, for instance, the potassium binds the nitrogen and oxygen loosely together in the state of saltpeter, and there is sulphur, a second combustible whose oxidation evolves greater heat than that of carbon. When chlorate of potash is present the chlorine plays the part of nitrogen, and is set free in the gaseous state. Two very unstable and practically useless explosive substances, the so-called chloride and iodide of nitrogen, contain neither carbon nor oxygen; but their great violence is equally caused by the feeble affinities of nitrogen for other elements, large volumes of gaseous matter being suddenly disengaged from a very small quantity of a liquid and solid body respectively.

Explosives may be conveniently divided into two distinct classes—(1) Explosive Mixtures, and (2) Explosive Compounds. The first class consists of those explosive substances which are merely intimate mechanical mixtures of certain ingredients, and which can be again separated more or less completely by mechanical means not involving mechanical action. These ingredients do not, as a rule, possess explosive properties in their separate condition. There are, however, explosives which might also be classed in both categories; for example, *picric powder* is composed of ammonium picrate and saltpeter, the former of which contains an explosive molecule, but is mixed with the latter to supply additional oxygen and thus increase the force. If a substance that will burn freely in air, combining gradually with the oxygen of the atmosphere, be ignited in pure oxygen gas, the combustion will be much more rapid and the amount of heat generated greater at the ordinary atmospheric pressure. If it be possible to burn the substance in a very condensed atmosphere of oxygen, we can readily imagine the combustion as very greatly accelerated, and therefore increased in violence; this is what is ordinarily effected by an explosive "mixture." A combustible body and a supporter of combustion are brought into extremely close contact with one another by means of intimate mechanical mixture; also, the supporter of combustion, or oxidizing agent, is present in very concentrated form, constituting what may be termed a magazine of condensed oxygen, solid or liquid. In the case of the explosion of a definite chemical compound, the change may be considered as the resolution of a complex body into simpler forms. This is not, however, always the case when a mechanical mixture is concerned; gunpowder, for example, may be said to contain two elementary substances, carbon and sulphur, not in chemical union. The chief explosive mixtures may be subdivided into "nitrate mixtures" and "chlorate mixtures." In the nitrates, the oxygen is held in combination with sufficient force to need a powerful disturbing cause to separate it, so that mixtures made from nitrates do not explode very rapidly, and their action is comparatively gradual; they are not sensitive to friction or percussion, and hence are to a great extent safe. Any of the nitrates will form explosive mixtures with combustible substances, but nitrate of potash (KNO_3) is the only one practically employed. The nitrate of soda, called "cubical" or Chili saltpeter, has been used, but absorbs moisture from the air so readily as to give very inferior results. Gunpowder may be taken as the representative of the nitrate explosive mixtures. Picric powder, already referred to, has been proposed by Abel for use as a bursting-charge for shells, as being more powerful than a corresponding charge of gunpowder, equally safe as regards friction or percussion, and less hygroscopic; it consists of two parts ammonium picrate and three parts saltpeter, incorporated, pressed, and finished very much as ordinary gunpowder. The chlorates part with their oxygen far more readily than the nitrates, the strong affinities of chlorine for the metals coming into play, and consequently chlorate mixtures are very sensitive to friction and percussion, and explode with great violence; chlorate of potash ($KClO$) is the only one used. Very many chlorate mixtures have been made, some of which are employed in fireworks. "White gunpowder" is a mixture of two parts chlorate of potash, one of yellow prussiate of potash, and one of sugar; it is exploded very easily by friction or percussion. The most important chlorate mixtures are those used for igniting other explosives, such as the composition for friction-tubes for firing cannon, percussion-cap composition, and percussion-fuses for bursting shells on impact; it is sometimes mixed with sulphur, as a combustible, and sometimes with black sulphide of antimony, which gives a longer flame.

In an explosive compound the elements are all in chemical combination, presenting a definite explosive "molecule," which contains, so to speak, both the combustible and the supporter of combustion in the closest possible union; we can therefore understand its action being much more sudden and violent than that of the most intimate mechanical mixture. The chief explosive compounds are formed from some organic substance containing carbon, hydrogen, and oxygen, by introducing into it, through the action of concentrated nitric acid, a certain portion of nitric peroxide (NO_2), in substitution for an equivalent amount of hydrogen. A new compound differing outwardly very little, if at all, from the original substance is thus formed, but in a very unstable state of chemical equilibrium, because of the feeble union of the nitrogen and oxygen in the NO_2 molecule. A slight disturbing cause brings into play the stronger affinity of the carbon and hydrogen for the large store of oxygen contained in the new compound. Gun-cotton and nitro-glycerine are the leading members of this group, being produced in a precisely similar manner by the substitution of three molecules of NO_2 for three atoms of hydrogen (H). As those explosives will be elsewhere described in detail, we give the formation as a representative member of the group of nitro-phenol or picric acid by treating phenol or carbolic acid with a mixture of nitric and sulphuric acids, the latter being required to absorb the water and preserve the full strength of the nitric acid:

Carbolic acid. Nitric acid. Picric acid. Water.

$$C_6H_6O + 3HNO_3 = C_6H_3(NO_2)_3O + 3H_2O$$

The formula of the product may be empirically written $C_6H_3N_3O_7$; it is, like gun-cotton and nitro-glycerine, a *tri-nitro* substitution product. Only the picrates or salts of picric acid formed with potassium or ammonium are used in practice as possessing more force than the uncombined acid. From starch may be obtained, in a strictly analogous manner, an explosive called *xyloidine*, which is a *bi-nitro* product, two molecules of nitric peroxide being substituted for two atoms of hydrogen. In the case of *nitro-mannite*, an explosive made from mannite, one of the sugars, as many as six molecules of the NO_2 are inserted. The number of nitro-substitution products is very great, many of them being more or less violently explosive. The fulminates are among the most violent of all explosive compounds, their chemical sensibility being very small. Sudden in action, their effect is great locally; thus they are well adapted to the purpose for which alone they are practically used, of igniting or upsetting the equilibrium of other explosives. Fulminate of mercury is produced by adding alcohol (C_2H_6O), under great precautions, to a solution of mercury in nitric acid; a gray crystalline precipitate is obtained, very heavy (sp. gr. 4.4), and so sensitive to friction or percussion that it is kept in the wet state. The results of analysis show one atom of mercury and two each of carbon, nitrogen, and oxygen; so that the formula may be empirically written $HgC_2N_2O_2$, or perhaps more correctly $HgO.C_2N_2O$; the chemical factor C_2N_2O is called *fulminic acid*, but has never been produced separately. Opinions differ as to the precise "rational" formulæ of the fulminates, some chemists considering their process of formation to be similar to that of the nitro-substitution products. It will be observed that two atoms of nitrogen take the place of hydrogen, being the ratio of combining proportions of those elements. The products of combustion are carbonic oxide, nitrogen, and metallic mercury, and the violence of action is due to the sudden evolution of a volume of gas and vapor very large in comparison with that of the substance, its density being so great. This fulminate enters into the composition used for percussion-caps and electric fuses; its practical value has of late years been immensely increased by the discovery of its power even in very small quantities to produce the almost instantaneous decomposition of several explosive substances. Fulminate of silver is prepared in a similar manner, but, being far more sensitive, is of little practical value; it is used in very minute quantities in making such toys as detonating crackers.

It may be generally concluded that the amount of force exerted by an explosive substance depends upon (1) the *volume of gas or vapor* produced by the transformation compared with that of the original substance; and (2) the *temperature of explosion*, which determines the extent to which the gases are expanded, or their tension increased; or in other words, the explosive force is directly proportional to the heat of combustion, and the volume of gas and vapor calculated at 0° C. and 7.60 mm. pressure, and *inversely* proportional to the specific heat of the mixed products. It has been supposed by Berthelot and others that the volume of gas produced may possibly be still further increased by the partial or total "dissociation" of the compound gases at the high temperatures concerned; for example, that the carbonic acid (CO_2) may be decomposed into carbonic oxide (CO) and oxygen, or the aqueous vapor into oxygen and hydrogen. However, Nobel and Abel demonstrate that in the former instance the loss of temperature consequent upon the absorption of heat by the decomposition would more than compensate for the increase of volume by dissociation. It must also be remembered that if the temperature be extremely high, so also is the pressure under which dissociation must take place. We may therefore consider that it has no sensible influence upon the explosive force. It is most important to distinguish between explosive force and explosive effect, the latter in great measure depending upon the rapidity with which the metamorphosis takes place, while the same amount of force may be exerted suddenly or gradually. We may, therefore, consider that the explosive effect varies *directly* as the volume of gas produced and the temperature of explosion, and *inversely* as the time required for the transformation. But the time, and, to a certain extent, the products and temperature, will vary with (*a*) the physical state of the explosive substance; (*b*) the external conditions under which it is fired; (*c*) the mode of firing or exploding. The physical or mechanical state of the explosive substance has a most important bearing upon the effect obtained from it. To prove this it is only necessary to point to the very different results given by gunpowders made with the same proportions of the three ingredients, but varying in density, and in shape and size of grains or pieces. Gun-cotton is even more affected by variations in mechanical condition. In the form of loose wool, it burns so rapidly that gunpowder in contact with it is not inflamed; plaited or twisted tightly, its rate of combustion in air is greatly modified. This is due to the fact that the inflammable carbonic oxide, which is evolved by the decomposition from the want of sufficient stored-up oxygen to oxidize completely all the carbon of the gun-cotton, cannot penetrate between the fibers and accelerate the combustion, but burns with a bright flame away from the surface of the twisted cotton; when the yarn is yet more compressed by any means, the temperature is not kept up to the height necessary for the combustion of the carbonic oxide, so that it escapes unconsumed, abstracting heat and yet more retarding the rate of burning. For the same reason, pulped and compressed gun-cotton burns comparatively slowly in air, even when dry; in the wet state it merely smoulders away, as the portion in contact with the fire successively becomes dried. Yet this same wet compressed gun-cotton can be so used as to constitute one of the most powerful explosives known. It is well known that gunpowder behaves differently when in the open air and under strong confinement; not only the rate of burning, but even, to a certain extent, the products of combustion are altered. We have discussed the effect of tightly plaiting or compressing gun-cotton; but when confined in a strong envelope, the whole of the inflamed gas, being unable to escape outwards, is forced into the interstices under immense pressure, and the decomposition is greatly accelerated. The amount of confinement or restraint needed by any explosive depends, however, upon the nature of the substance and the mode of exploding it, becoming very much less as the transformation is more rapid, until it may be said to reach the vanishing-point. For example, the very violent explosive chloride of nitrogen is usually surrounded, when exploded, with a thin film of water. Abel states that if this film, not exceeding $\frac{1}{1000}$ inch in thickness, be removed, the explosive effect is much lessened. Nitro-glycerine, again, when detonated by a fulminate, is sufficiently confined by the surrounding atmosphere. By the same means, gun-cotton may explode unconfined if compressed, the mechanical cohesion affording sufficient restraint. In the case of wet compressed gun-cotton, which can be detonated with even fuller effect than dry, the mechanical resistance is greater, the air-spaces being filled with incompressible fluid.

The manner in which the explosion is brought about has a most important bearing upon the effect produced. This may be done by the direct application of an ignited or heated body, by the use of an electric current to heat a fine platinum wire, or by means of percussion, concussion, or friction, converting mechanical energy into heat. A small quantity of a subsidiary explosive, such as a composition sensitive to friction or percussion, is often employed, for the sake of convenience, to ignite the main charge, the combustion spreading through the mass with more or less rapidity, according to the nature of the substance. Although subsidiary or initiatory explosives were at first used merely to generate sufficient heat to ignite the charge, and are often still so employed, they have of late years received an application of far wider importance. Mr. Alfred Nobel, a Swedish engineer, while endeavoring to employ nitro-glycerine for practical purposes, found considerable difficulty in exploding it with certainty; he at length, in 1864, by using a large percussion-cap, charged with fulminate of mercury, obtained an explosion of great violence. This result led to the discovery that many explosive substances, when exploded by means of a small quantity of a suitable initiatory explosive, produce an effect far exceeding anything that can be attributed to the ordinary combustion, however rapid, of the body in question; in fact, the whole mass of the explosive is converted into gas with such suddenness that it may, practically, be considered instantaneous. This sudden transformation is termed "detonation." Of the substances capable of producing such action, fulminate of mercury is the most important. Some explosives appear always to detonate, in whatever manner they may be exploded, such as chloride and iodide of nitrogen; the explosive effect is therefore much greater than that of a slower explosive substance, although their explosive force may be less. Again, other substances, such as gun-cotton and nitro-glycerine, are detonated or not, according to the mode of explosion. Indeed, Abel has proved that most explosives, including gunpowder, can be detonated, provided the proper initiatory charge be employed. Roux and Sarrau have divided explosions into two classes or orders—"detonations" or explosions of the first order, and "simple explosions" of the second order. They made a series of experiments with the object of determining the comparative values of various explosive substances, detonated and exploded in the ordinary manner; the method employed was to ascertain the quantity of each just sufficient to produce rupture in small spherical shells of equal strength. These experiments, although valuable, cannot be considered as affording a precise method of comparison; the results would be affected, *inter alia*, by the impossibility of insuring that the shells were all of the same strength—a point of great importance, considering the very small weights of each explosive used; also, the rate of combustion, and therefore the explosive effect, of gunpowder is materially affected by its mechanical condition, so that different powders would give a varying standard of comparison. However, they afford fair evidence that, when detonated, gun-cotton has about six times, and pure nitro-glycerine about ten times, the local explosive effect of gunpowder simply ignited in the ordinary manner; nitro-glycerine is usually employed in the form of "dynamite," mixed with some inert absorbent substance, so that its power is proportionately reduced.

The rationale of detonation is not yet understood. If the transformation were due merely to the mechanical energy of the particles of gas, liberated from the initiatory charge at a tremendous velocity, being converted into heat by impact against the mass of the explosive substance, then it would follow that the powerful explosive would be the best detonating agent. This, however, is not the fact; for a few grains of fulminate of mercury in a metal tube will detonate gun-cotton, whereas nitro-glycerine, although possessed of more explosive force, will not do so unless used in large quantities. The fact of its being possible to detonate wet gun-cotton is also a proof that the action cannot be due to heat alone. It would rather seem to be what Professor Bloxam terms "sympathetic" explosion. The experiments of Abel, as well as those of Champion and Pellet in France, appear to indicate a vibratory action of the detonating agent upon the ultimate particles of the substance to be exploded. An explosive molecule is most unstable, certain very delicately balanced forces preserving the chemical and physical equilibrium of the compound. If these forces be rapidly overthrown in succession, we have explosion; but when, by a blow of a certain kind, they are instantaneously destroyed, the result is detonation. Just as a glass globe may withstand a strong blow, but be shattered by the vibration of a particular note, so it is considered by some authorities that, in the instance cited, the fulminate of mercury communicates a vibration to which the gun-cotton molecule is sensitive, and which overthrows its equilibrium; it is not sensitive to the vibrations caused by the nitro glycerine, which only tears and scatters it mechanically. Although the action of detonation has been spoken of as instantaneous, and may practically be so considered, yet a certain infinitesimal duration of time is required for the metamorphosis; different substances possess, doubtless, different rates of detonation, for we can scarcely conceive of a mechanical mixture, such as gunpowder, being so sensitive to the action of the detonating impulse as a definite chemical compound, and the rate even varies slightly, for the same explosive, with its physical state. It has been shown by means of the chronoscope that well compressed gun-cotton, when dry, is detonated at a velocity of from 17,000 to 18,000 feet a second, or about 200 miles a minute; by using a small primer of dry gun-cotton, the same substance in the wet state may be detonated at an increased rate of from 18,000 to 21,000 feet a second, or about 240 miles a minute. The following table shows the potential energy, in foot-tons, calculated from the heat of combustion for each explosive, determined by Roux and Sarrau, in the experiments already referred to; that for gunpowder is the mean given by five kinds:

Explosive Substances.	Potential energy per lb. Foot-tons.
Gunpowder	480
Gun-cotton	716
Nitro-glycerine	1139
Picrate of potash	536
Picrate of potash and saltpeter	615
Picrate and chlorate of potash	781
Chloride of nitrogen	216

The above figures naturally direct our attention to the small amount of work stored up in even the most violent explosive substance, compared with the potential energy of 1 pound of coal, which is about 4980 foot-tons. Nobel and Abel point out that this great difference is due not alone to the fact that the coal draws its oxygen from the air, but also to the necessity that the explosive should expend a considerable amount of work in converting its condensed magazine of oxygen into gas, before it can combine with the carbon; further, with reference to the economical value of the work done, that the oxygen used by the coal costs nothing, whereas much expense is incurred in condensing the oxygen into the explosive substance. The practical value of any explosive must depend greatly upon the object to be attained. It is essential to distinguish between explosive force and effect; the more sudden the action the more local will be the effect produced, and hence the very violent explosive substances are useless as propelling agents for heavy guns or small-arms, since they would destroy the weapon before overcoming the inertia of the projectile. It is true that gun-cotton, prepared in various forms, and mixed with other substance to moderate its action, as well as a similar compound made from sawdust, an inferior form of cellulose, are sometimes used with small-arms; but in addition to a want of uniformity in action, the strain caused by such substances would be far too great in the large charges needed for heavy guns. Again, there are cases, even in mining or blasting operations, for instance, when it is desired to displace large masses of earth or soft rock, in which a comparatively slow explosive, such as gunpowder, would give better results than gun-cotton or dynamite. However, speaking generally, gunpowder in some one of its forms is far the most valuable as a propelling agent, while for destructive purposes the last-named substances are much more effective, especially when detonating. See *Explosion*, *Fulminates*, *Gun-cotton*, *Gunpowder*, *High Explosions*, *Nitro-glycerine*, and *Picrates*.

EXPLOSIVE MACHINES.—Very ancient machines of war employed by the Greeks. They were somewhat like the air-cannon or air-gun of the present day, but on a more gigantic scale.

EXPRESS RIFLE.—A modern sporting-rifle of great killing power. This rifle takes a large charge of powder and a light bullet, which gives a very high initial velocity and a trajectory practically a right line up to 150 yards, hence the term *express*. To increase the killing power of the bullet, it is made of pure lead and has a hollow point. Upon striking the object, the bullet spreads outwardly, inflicting a fearful death-wound. This arm is well adapted to meet the wants of those who hunt large game at short range. It is a modification of the Winchester, model 1876, and differs from it only in caliber (.50), and in the cartridge to which it is adapted. This last contains 95 grains of powder and a bullet weighing 300 grains. The cartridges may be loaded with hollow-pointed, solid, or split-pointed bullets, as may be desired. All these bullets weigh 300 grains each, and their shooting qualities are about equal. The primer is the No. 2½ Winchester. The powder used in loading the cartridges at the factory is United States Government Musket,

but any of the approved brands of powder suitable for large cartridges can be used. As has been noticed, the bullet having a high initial velocity, a very flat trajectory is obtained, and no change in sighting is required up to 150 yards, thus enabling the hunter to avoid missing the game through error in calculating distances. The recoil is not greater than that of a 12-gauge shotgun using ordinary charges; this model, as made up for the English market with a 22-inch barrel and with full-length magazine, weighs but 8½ pounds. If desirable, a small explosive cartridge can be dropped into the cavity in the point, making it an explosive bullet. A caliber as large as .57 is much used in England, but the .50 caliber is considered sufficient in the United States. See *Winchester Rifle*.

EXPUGNABLE.—In a military sense, a term for that which is capable of being taken by assault, forced, or conquered.

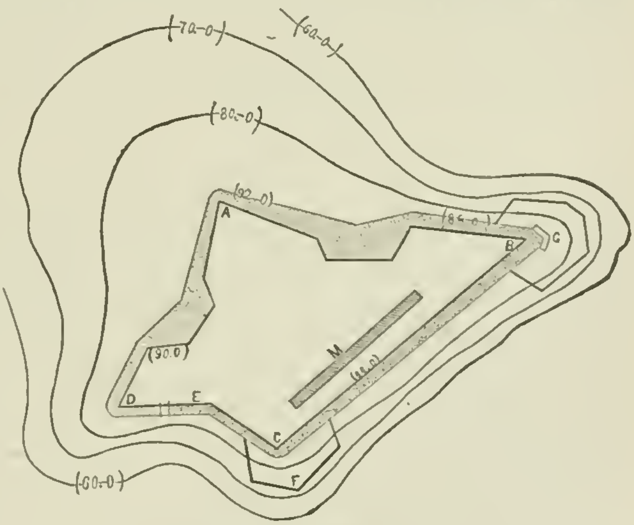
EXTEND.—A term peculiarly applicable to light-infantry movements when the files are frequently loosened and the front of the line extended for the purpose of skirmishing. When the divisions of a column are made to occupy a greater space of ground, they are said to extend their front. See *Extended Order*.

EXTENDED ORDER.—A light-infantry maneuver which is frequently practiced. It comprehends the opening of files of a battalion or a company standing two deep, so as to have just space enough for one man between each two. The battalion or company, after it has obtained all its relative distances and been halted, is fronted, and each rear-rank man springs into the vacancy when the word of command is given.

EXTERIOR CREST.—In fortification, the crest of the exterior slope of a parapet. See *Exterior Slope* and *Fortification*.

EXTERIOR DEFENSES.—Detached works should not only receive a strong profile, but have accumulated in their front every accessory obstruction that will best impede the assailant in an attempt at an open assault, and if not flanked from the parapet be provided with secure ditch-defenses. The arrangement for the armament should be of the most substantial character for heavy guns and mortars. Bomb- and splinter-proof shelters should be provided for the security and lodging of the garrison, and in works open at the gorge these should be placed across the gorge and be loop-holed to meet an assault in the rear. If the ground in advance of these works is not well swept by their fire, or that of the connecting intrenchments, the ordinary trench, now better known as rifle-pits, should be made for this service. Besides these, good covered communications for field-guns should be arranged so that batteries may be speedily moved from point to point, where their services may be most needed. These covered-ways should also be arranged for the use of musketry. The plan of these works will depend upon the character of their site and the more or less exposed position of it to the fire of the assailant. For the most important, bastioned forts will be the best; for others, the star-fort redoubt; or simply lunettes or redans will suffice. No specific rules can be laid down, as everything must depend on the judgment and skill of the engineer charged with planning the defenses.

The drawing represents the topography of a site, and the general plan of a fort for its immediate defense, and in reciprocal defensive relations with other works on its flanks. The fronts A B and A D are bastioned, and so placed that the fire from their faces and curtains, armed with heavy guns, can sweep the approaches on the collateral works; their flanks, armed with guns of smaller range, sweeping the principal approach to the work and flanking the ditches of the salient A. The front D C, to suit the configuration of the ground, is tenailled, and the front B C, for the same reason, is simply a right line, with only sufficient relief to sweep the approaches in front and be secure from a fire of musketry. For the better flanking of the ditch of the face at the salient B and the front B C, a counterscarp-gallery is placed in front of B. Rifle-pits are arranged at F and G to sweep the steep ground in advance of the fronts A B, B C, and C D. As the site admitted of some discretion in fixing the salient A, and the direction of the two fronts A B and A D, these are supposed to have been so determined as to avoid all enfilading and re-



Plan of Exterior Defenses of a Fort.

verse views on these two fronts. The command of these two fronts from A, each way to the opposite flanks, is supposed to be so regulated as to sweep the approaches on the two fronts and to cover all the interior from plunging fire. The outlet is at F, and a bridge leads from it across the ditch to the road which passes around the salient D, along the ridge in front of A. M represents the bomb-proof barrack, covered in front by the parapet and arranged as a keep.

In the exercise of his judgment the engineer will be called upon to make a particular study of and draw up memoranda on the general plan of defense for the whole position to be occupied, in which he will have to consider its extent and its topographical and military features; the side towards which it must be particularly fortified; the defensive and offensive character of the fortifications best adapted to it; its most striking tactical points both absolutely and relatively to the general plan of defense; the number of troops by which it is to be occupied; and the time in which, with the means at his disposal, the fortifications can be erected. These general points having been settled, the next step will be to consider the most suitable kind of work for each point, taking into account all natural and artificial obstructions that will contribute to the defense, the tactical relations of each work to the others, and the best distribution of the troops for each one. The discussion of the peculiar features of each work as to its profile, defilement, and construction will finally be fixed in accordance with the natural and artificial features of the site exterior to the works, the nature of the ground itself, and the disposable means that the locality itself may furnish for the construction of the work. All of this demands, on the part of the engineer, a thorough knowledge of general principles and an acquaintance with all the details and resources of his art. See *Fortification*.

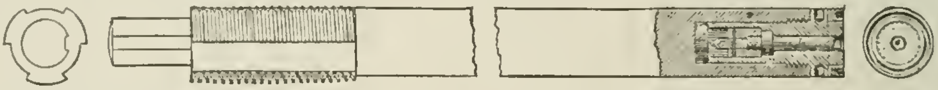
EXTERIOR FORM OF CANNON.—The exterior form of cannon is determined by the variable thickness of the metal which surrounds the bore at different points of its length. In general terms, the thickness is greatest at the seat of the charge, and least at or near the muzzle. This arrangement is made on account of the variable action of the powder and projectile along the bore, and the necessity of disposing the metal in the safest and most economical manner; or, in other words, to proportion it according to the strain it is required to bear. It has been proposed to determine the pressure of the powder at the different points of the bore by supposing all the gases evolved in the first moment of combustion, and, as the space behind the projectile increased, applying Mariotte's law, that the tension of gas is proportional to its density, which, in turn, is inversely proportional to the space it occupies. This method of determining the pressure gives a very rapid taper to the exterior; and however well it may answer for cast-iron cannon, is unsuitable for those made of bronze; which are found in practice to burst in the chase, in consequence of the enlargement of the bore from the striking of the projectile against its sides. About the year 1841 Colonel Bomford devised a plan for determining this pressure by direct experiment. It essentially consisted in boring a number of small holes through the side of a gun, at right angles to its axis, the first hole being placed at the seat of the charge, and the others at intervals of one caliber. A steel ball was projected from each hole, in succession, into a target or ballistic pendulum by the force of the charge acting through it; and the pressures at the various points were deduced from the velocities communicated to the balls; it was by this means that the form of the columbiads was determined. This plan has been lately tried in Prussia with great care and success. Instead of the projectile, Captain Rodman uses a steel punch which is pressed by the force of the charge into a piece of soft copper. The weight necessary to make an equal indentation in the same piece is then ascertained by the "testing-machine," or a machine employed to determine the strength of cannon-materials. This instrument is known as the "pressure-piston," and is used in proving powder to measure the strain which is exerted on the bore of the eprouvette or gun.

In estimating the effect of any force upon a yielding material to which it may be applied, the rate of application, or the time which elapses from the instant when the force begins to act until it attains its maximum, should not be neglected; for, with equal ultimate pressures per square inch of surface, that powder will be most severe upon the gun which attains this pressure in the shortest period of time after ignition. The smaller the grain the more rapid will be the combustion of any charge of powder (other things being equal), and hence the greater will be the strain on the gun in which it is burned. The strains to which all fire-arms are subjected are four in number, viz.: 1st. The *tangential* strain, which acts to split the piece open longitudinally, and is similar in its action to the force which bursts the hoops of a barrel. 2d. The *longitudinal* strain, which acts to pull the piece apart in the direction of its length. Its action is the greatest at or near the bottom of the bore, and least at the muzzle, where it is nothing. These two strains increase the volume of the metal to which they are applied. 3d. A strain of *compression*, which acts from the axis outward, to crush the truncated wedges of which a unit of length of the piece may be supposed to consist. This strain compresses the metal and enlarges the bore. If the metal were incompressible, no enlargement of the bore would result from crushing; and any enlargement of the bore caused by the action of the tangential force would be accompanied by a corresponding enlargement of the exterior diameter of the piece; and hence the absolute extension of the metal, at the inner and outer surfaces of the gun, would be inversely as the radii of these surfaces. 4th. A *transverse* strain, which acts to break transversely, by bending outward the *staves* of which the piece may be supposed to consist. This strain compresses the metal on the inner, and extends it on the outer surface. The resistance which a bar of iron, supported at its extremities, will offer to a pressure uniformly distributed over it, is directly as the square of its depth, and inversely as the square of its length. See *Cannon* and *Ordnance*.

EXTERIOR SIDE.—The side of a polygon upon which a front of fortification is formed. Taking the height of parapet at 8 feet and the depth of the ditch at 6 feet, the relief of 14 feet will be the least used; taking the height at 12 feet and the depth at 12, the corresponding relief of 24 feet will be the greatest used. Assuming the superior slope at $\frac{1}{6}$, the least length of curtain for the least relief is 56 yards; the least length for the greatest relief is 96 yards. For a curtain of 56 yards in length, the exterior side must be about 125 yards long; for the curtain of 96 yards, the exterior side must be 250 yards long. The least length of the exterior side will therefore be between 125 and 250 yards, depending upon the relief of the work. The greatest length of the exterior side depends upon the length given to the line of defense. If the weapon used to arm the flanks is the rifled musket—the weapon now used by infantry—its close and effective range determines the length of the line of defense. The limit of accurate aim for the ordinary soldier is about 300 yards. Assuming this to be the length of the line of defense, the exterior side will be about 400 yards long, and will be the greatest length ordinarily used. See *Field-fortification*.

EXTERIOR SLOPE.—In a fortification, the surface connecting the superior slope with the ground in front. The exterior slope *is the same that the earth naturally assumes*. Any means used to make it steeper would be injurious; because such would be soon destroyed by the enemy's fire, and the earth giving way, the necessary thickness of the parapet would be diminished. See *Field-fortification*.

EXTERNAL PRESSURE-GAUGE.—A form of pressure-gauge variously employed. The drawing shows a form for taking pressures at the bottom or at any point along the surface of the bore. The length of the plug in which the gauge is screwed is such that its bottom reaches to and forms a part of the bore at the position where the pressure is to be taken. The plug has a sectional screw to facilitate its insertion or withdrawal,



External Pressure gauge.

and the rim of the plug is provided with a gas-check to cut off the gas from the surface of the plug. See *Pressure-gauge*.

EXTORTION.—Under the modern laws of war, honorable men no longer permit the use of any violence against prisoners in order to extort information or to punish them for having given false information.

EXTRACTOR.—An instrument used in extracting a projectile from a muzzle-loading rifled gun. That introduced into the service for the various calibers of projectiles is constructed to act independently of the grooves of the gun. The term *extractor* is given to some other articles of artillery stores, such as the extracting implement used with the Gatling gun, and the instrument used in extracting a fuse from a shell.

EXTRADITION.—The Federal Constitution provides that "A person charged in any State with treason, felony, or other crime, who shall flee from justice and be found in another State, shall, on demand of the executive authority of the State from which he fled, be delivered up to be removed to the State having jurisdiction of the crime." As to foreign countries, extradition is regulated by special treaties, and the United States has such treaties with Great Britain, France, the Hawaiian Islands, most of the States now forming the German Empire, and with that Empire, Austria, Sweden and Norway, Italy, Switzerland, Venezuela, the Dominican Republic, Nicaragua, Hayti, and Mexico. These treaties provide for extradition in cases of the higher crimes, such as murder, assault with intent to kill, piracy, arson, robbery, forgery, rape, embezzlement by public officers, burglary, etc. Proceedings in cases of extradition are carefully defined and guarded by law. Political offenders, even though making war upon their own Government, are not subject to extradition. There are some treaties made between the United States and several Indian tribes, recognized as nations or distinct communities, in some of which the Indians have stipulated to surrender to the Federal Authorities persons accused of crimes against the laws of the United States.

EXTRA DUTY.—Although the necessities of the service may require soldiers to be ordered on working-parties as a duty, Commanding Officers should bear in mind that fitness for military service by instruction and discipline is the object for which the army is kept on foot, and that they are not to employ the troops when not in the field, and especially the mounted troops, in labors that interfere with their military duties and exercises, except in case of immediate necessity, which should be forthwith reported for the orders of the War Department. Extra-duty men should attend the weekly and monthly inspections of their companies, and, if possible, one drill in every week. Private soldiers employed in hospitals as cooks and nurses continuously for a period exceeding ten days are paid the lowest rate of extra-duty pay, by the Paymaster, on the hospital muster-rolls. Enlisted men of the Ordnance and Engineer Departments, Hospital Stewards, and Ordnance and Commissary Sergeants, do not receive extra-duty pay, unless under special authority of the Secretary of War. The company artificers, farriers, blacksmiths, and wagoners receive no extra pay except when detailed on extra duty in the Quartermaster's Department, wholly disconnected with their companies. Soldiers detailed as Acting Superintendents of National Cemeteries while so acting are entitled to extra pay as Overseers. Signal Service men do not receive extra-duty pay unless specially directed by the Secretary of War. The following Signal Service men are authorized to receive extra-duty pay at the rate of thirty-five cents per day: Non-commissioned officers in charge of sections; Corporals and privates in charge of stations, or serving as operators; and repair-men on the United States telegraph lines carrying, or which may carry, commercial business. Soldiers employed as scouts are not to be paid extra-duty pay, it being a military duty to which they are liable. A prisoner undergoing sentence does not receive extra-duty pay. Enlisted men being liable to perform guard and other military duty are entitled to extra pay when employed on extra duty more than ten days in a month, though the employment may not have been continuous. Eight hours constitute one day's work for all persons who are employed and paid by the day, by or on behalf of the Government of the United States. This does not extend to persons who are paid regular salaries. Watchmen, clerks, messengers, and others, whose time may be necessary at any or all hours, are not considered to be embraced within the terms of the law. Men on extra-duty pay are held to such hours as may be expedient and necessary; but except in case of urgent public necessity, as in military operations, when they must work regardless of hours, not more than ten hours' labor should be required. But when more than eight hours' work is required in any one civil day, the soldier rendering the service will be paid for more than a day's labor, in proportion to the time actually employed. In ordinary cases the hours of work should be so regulated as to agree, as far as possible, with the hours established in civil work in each locality. See *Duty*.

EXTRAORDINARIES OF THE ARMY.—In the British service, the allowances to the troops beyond the gross pay in the Pay Office. Such are the expenses for barracks, marches, encampments, Staff, etc.

EXTRAORDINARII.—In the ancient Roman army, a select body of men consisting of the third part of the foreign cavalry and a fifth of the infantry. These were carefully separated from the other forces borrowed from the Confederate States, in order to prevent any treacherous coalition between them. From among the Extraordinarii a more choice body of men were drawn, under the name of *Ablecti*.

EXTREME RANGE.—The distance from the piece to the point at which the projectile is brought to a state of rest. *Greatest range of a piece* is the farthest distance to which it will throw a projectile, the piece being mounted on its appropriate carriage. All ranges are expressed in yards. In air, the maximum range, under all ordinary circumstances, is obtained from an angle not far from 34 degrees. See *Range*.

EYE-SPLICE.—A splice made by turning the end of a rope back on itself and splicing the end to the standing part, leaving a loop. See *Cordage*.

F

FABIAN.—Delaying; dilatory; avoiding battle, in imitation of Quintus Fabius Maximus Verrucosus, a Roman General who conducted military operations against Hannibal, by declining to risk a battle in the open field, but harassing the enemy by marches, counter-marches, and ambuscades.

FABRICATION OF FIRE-ARMS.—With the exception of swords and patent arms, all small-arms for the United States army and militia are made at the National Armory, now situated at Springfield, Mass. This Armory is under the general charge of the Chief of Ordnance, who, by the authority of the War Department, furnishes the models and prescribes the kind and quantity of work to be done; the operations are conducted by civilians. A principal requisite, in the manufacture of small-arms, is that similar parts of the same kind of arm, or *model*, shall be capable of interchange. This demands a higher degree of accuracy in the workmanship than can be attained by hand-labor, without great cost, and the consequence is that machinery is now very generally employed in this branch of manufacture. The principal operations of manufacturing arms are *welding, swaging, boring, turning, drilling, tapping, milling, cutting and filing, grinding, case-hardening, tempering*, and *polishing*. Welding and swaging are performed by blacksmiths; the other operations, by armorers or finishers. For the purpose of minutely investigating the fabrication of fire-arms, we will notice in detail the various processes and operations performed in the manufacture of the Springfield rifle, caliber .45 inch. The subject will be more readily embraced by following the work in detail through the forging department and subsequent operations.

Rolling barrels—A Springfield gun-barrel is made from a 2-inch round bar of decarbonized steel. The first operation is to cut the bar into lengths of 9.25 inches each; the second is to center both ends of each piece; the third is to drill a hole ⅝ inch diameter through the entire length of the piece, forming a tube, called a "barrel-mold," which, for a rifle, weighs 7 pounds, and a carbine 6 pounds. The mold is heated and then drawn out between grooved rolls. Each set of rolls has eight grooves, two of them cylindrical and six taper. In connection with the grooves eight mandrels are used, which vary in diameter of knob from .75 to .37 inch. Four molds are placed in a reverberatory furnace and brought to a red heat. A workm:n then thrusts the largest mandrel through one of them, while still in the furnace. He then carries it to the rolls, and placing the mandrel through the frame, introduces the end of the mold into the first of the cylindrical grooves. The action of the rolls is to draw the mold over the mandrel. The cylinder is straightened by striking it on a flat iron table, and placed in the furnace to be reheated. The molds are run through the first groove in succession, after which the second-sized mandrel is used. The cylinders are run through the second groove in the same manner. The remaining grooves are made of the same shape as the required barrel. The cylinders are passed breech foremost through these, precisely as before, each cylinder being reheated after passing through any one groove except the last one, through which it is passed three times to give the required form. A ninth groove is on the rolls, but it is only used when, as rarely happens, the barrel appears to be running a little short. When the first four molds have reached the third groove, four additional molds are placed in the furnace. Thus the supply is constant without risk of burning the metal. One hundred and fifty can be rolled per day of eight hours with one set of rolls. One roller and two helpers are required for each set of rolls. One furnace can heat molds sufficient for two sets of rolls. From 5 to 8 pounds of coal are used per barrel *Cutting off*—The barrel, after passing through the last groove and while still hot, is cut to a length of 33 inches for the rifle, and to 22¼ inches for the carbine, by a set of two circular saws. *Straightening*—The barrel is placed in the straightening-machine, which is composed of two dies each of the length and shape of the half-barrel, and which close upon each other as the workman turns the barrel about its axis with a pair of tongs. *Annealing*—The barrels are again placed in a reverberatory furnace, brought to a red heat, taken out, and packed in cast-iron boxes in alternate layers with fine charcoal. Each box contains about 80 barrels. This operation renders the barrels less brittle, and also makes them easier to turn, file, etc. They remain in the charcoal from three to five days before they are cool enough to be removed. *First straightening*—The barrels are then straightened partly on an anvil with a common hammer and partly under a drop-hammer. *First and second boring*—The barrels are now "first-bored" with two twist-augers, of .37 and .42 inch diameter respectively, in a swift boring-machine, and "second-bored" with a quadrangular auger ribbed with splints, to a caliber of .44 inch. In the first boring the augers are drawn through the bore rather than pushed. In the second and additional borings the cutting is done in both directions. *First milling*—The rough ends left by the circular saws are squared up in a hand milling-machine, shown in Fig. 1, the spindle of which carries a cone of several grades. *First turning*—The barrel is placed in a lathe and a portion at the breech is turned down to receive a "dog" (a contrivance for holding the barrel in the

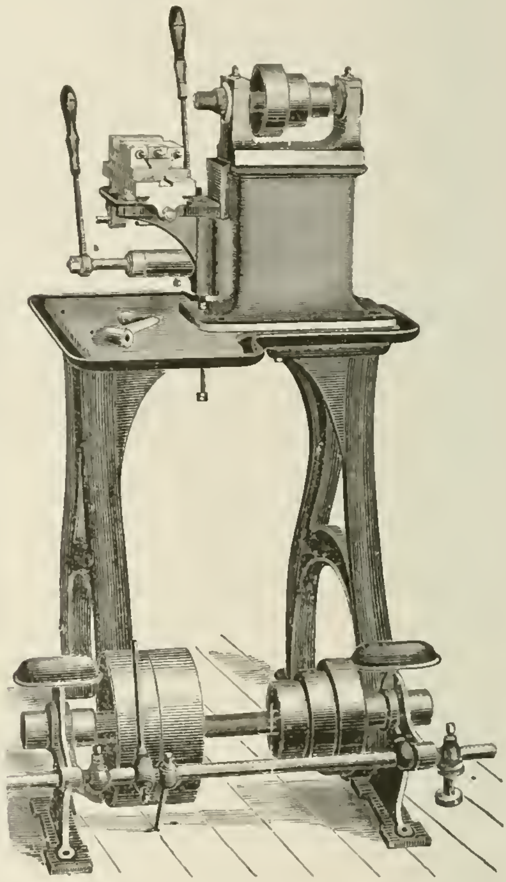


FIG. 1.

turning-lathes), after which a ring of Babbitt-metal is cast around the middle of the barrel. This ring is turned down smooth to give a bearing for a support which prevents the barrel from springing while the cutter is turning down the rough exterior. The lathe for this portion of the work is shown in Fig. 2. *Second turning*—One half the length of the barrel is now turned down, after which it is taken from the lathe, the ring knocked off, and the other half completed. During the latter half of the turning the support bears against the smooth surface of the part first turned off. *Second straightening*—The barrel is now straightened on the interior by the use of the anvil and hammer. The accuracy of this work is determined by holding the barrel up to the light and reflecting the image of a straight-edge from the surface of the bore. If the barrel be straight, the reflected image will be straight in all positions of the barrel. *Third turning*—The barrel is placed in a lathe and .05 inch turned off throughout its whole length. *Third boring*—It is again bored in a manner similar to the second boring, the caliber being brought up to

.4445 inch. *Second milling*—The muzzle is now milled for a few inches to the true taper to serve as a guide to the grinder. *Grinding*—The barrel is ground very nearly to its true size on a large and rapidly-revolving grindstone. *Proving*—At this stage the barrels are proved. About 40 are loaded with 280 grains of musket-powder, a paper wad, a lead slug weighing 500 grains, and a paper wad over all. The barrels are clamped down in a semicircular bed and fired by a train. The operation is repeated, except that the powder-charge is 250 grains. After each fire the letter P is stamped by an Inspector on the under side, near the breech, of all barrels which endure the test. To prevent mistakes the stamping is done before the barrels are removed from the proof-house. *Muzzle-filing*—The muzzle is filed to remove the roughness left by the milling, and to bring it to shape for receiving the bayonet-socket. It is done in the turning-lathe. *Third milling*—The breech end is squared up smoothly. *Sighting*—The barrel is placed in the milling-machine, and a seat for the front sight milled out. The ends of the seat are undercut, leaving the upper edges comparatively thin. The edges are turned up with a chisel and hammer and the roughly-formed sight pressed in the seat. cally through the spindle and pushes the cutters out more and more until the operation is completed. When the grooves are cut to the required depth the automatic device for feeding the rod ceases to act, a pawl being lifted from a ratchet by a spring. The cutters then move back and forth until the grooves are thoroughly polished. The pushing out of the cutters takes place just after they have passed clear through the barrel, so that the cutting is done as the spindle is withdrawn. An automatic arrangement also turns the barrel one third of a revolution about its axis each time the cutters leave the breech-end of the bore. The cutters then enter different grooves. By this means the grooves are made of equal widths and depths, since any little variation due to the size of a cutter is eliminated by the others. Each cutter enters all the grooves many times before the rifling is completed. *Second muzzle-filing*—The barrel is placed in a turning-lathe, and the muzzle is accurately filed in front and in rear of the sight. *Finishing muzzle*—The portion of the muzzle which is prevented by the sight from being filed while the barrel is revolving is filed off by hand. *Jigging front sights*—A jig is placed over the sight, and the sight is then filed down to size. *Sixth milling*—This consists in slightly rounding off

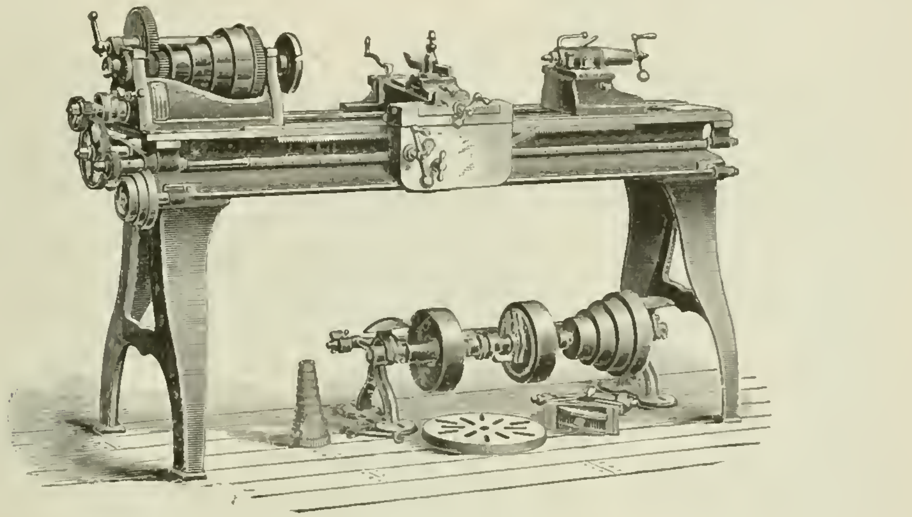


FIG. 2.

The edges are then driven down, bearing against the sight so as to hold it in position. The barrel is then carried to the brazing-room and the sight is brazed on. *Fourth milling*—The front end of the sight is milled off so that the required distance shall remain between the sight and the muzzle. *Front-sight filing*—This consists in filing around the sight after the brazing. *Fifth milling*—The muzzle-end is smoothly squared up. *Fourth boring*—Reams out the barrel to a caliber of .4465 inch. *Fifth boring*—Reams out the barrel to a caliber of .45 inch. *First polishing*—About 5 inches at the breech-end are polished on a buff-wheel. *Second polishing*—The barrel, placed in a vertical polishing-machine and held by the portion already polished, is moved rapidly up and down and at the same time turned about its own axis between clamps, the surfaces of which are covered with emery and oil. *Rifling*—The barrels are rifled in a machine specially prepared for this purpose. A hollow spindle, armed with three cutters, is moved uniformly through the barrel, entering at the muzzle. The spindle has also a uniform motion about its axis sufficient to cause one revolution in 22 inches. At the end of the stroke the motion is reversed and the spindle withdrawn. The cutters are let in the surface of the spindle and held by springs. A conical rod is moved automatithe corners or edges at muzzle. *Inspections*—The barrels are carefully inspected after rolling, first and second borings, third turning, third boring, second milling, grinding, proving, fourth and fifth borings, second polishing, rifling, second muzzle-filing, and sixth milling. These inspections are for ascertaining the quality of the work and material, and for gauging as to size.

The material from which the bayonet-blade is formed is a cast-steel bar, cross-section .625 inch square, the length of which is sufficient to bring up the weight to 14 ounces. *Cutting*—The bar is cut into suitable lengths by a large pair of shears worked by power, and is determined as follows: A tube containing water is capable of receiving 14 ounces of steel without causing the water to run over. The bar enters the tube, and when the water rises to the level the bar is cut off. The intention is that the same amount of stock shall be in each bar. *Neck-rounding*—Each piece thus cut off is heated and a small round head formed at one end, under a pony-hammer. A neck connects the head with the bar. *Rolling*—The bars are placed in a reverberatory furnace. When brought to a red heat a bar is taken out by a workman with a pair of tongs and inserted in the first of the nine grooves on the surface of the rolls. It is then inserted in each groove in succession up to the fourth, through which it is passed three times. It is then passed through each of the remaining grooves, after which it is inserted up to the neck in a cast-iron box filled with fine charcoal, where it undergoes annealing. No reheating is necessary throughout the whole operation. The first four grooves serve merely to draw out the bar, while the others flute the blade. *Neck-heading*—The head and neck are heated, the neck bent at right angles to the blade under a drop-hammer, and the head upset under a trip hammer, to form a broader surface for receiving the socket-plate. The socket-plate is of wrought-iron, forged and trimmed from a piece 2.35 inches square by ¼ inch in thickness. It is pickled in oil of vitriol and water heated by steam, before it is welded to the blade. *Socket welded on*—The socket-plate and head of the blade are heated, the plate placed on the head, and quickly welded to it by a trip-hammer. The socket is reheated, trimmed by a pair of shears, and curved over a mandrel by a hand-hammer. *Lap-welding*—The socket is reheated, a mandrel inserted, and the edges welded together in a die under a trip-hammer. The socket is again heated, placed in a die under another trip-hammer and brought to shape. *Neck-swaging*—The socket and neck are again heated and their position with respect to the blade determined by a drop-hammer forcing the different parts into a die. *Annealing socket*—The bayonets are placed in the annealing-furnace, and the blades for the greater portion of their length passing downward between the bars of a grate. Charcoal is laid on the grate, over the socket-necks and upper portion of the blades. A fire is started and the parts mentioned are heated to a red heat. The charcoal burns away and the metal cools slowly, remaining in the furnace about 48 hours. The lower portions of the blades do not require annealing, as they are annealed immediately after rolling. *Pickled*—The bayonets are vitrioled as before explained. *First boring*—The sockets are roughly bored nearly to size. *First turning*—The exterior of the socket is turned off except at the bridge. *Burring sockets*—The fin at each end of the socket is filed off by hand. *Straightening blade*—The blade is straightened on an anvil preparatory to milling. *First facing*—The face of the blade next to the neck is now milled off for a distance of about three inches. *Milling blade*—The grooves and edges are milled, bringing the blade nearly to the required size. *Punching points*—The end of the blade is punched in a die nearly to shape and size. *Heeling and pointing*—The point of the blade and the sides at the point of junction with the neck are milled to the required form. *Tempering*—The blade is heated to a cherry red and then plunged into brine. This renders it very hard and brittle. The blade is then coated with sperm oil and heated until the oil is burned off, when it is left with a spring temper. It is then straightened on an anvil. *Buffing edge*—The edges are straightened and smoothly buffed on a horizontal buff-wheel. *Buffing face*—The face of the blade is buffed to remove the rough surface left in milling. *Buffing back and point*—The three edges of the point are also buffed to give a smooth surface for polishing. *First punching*—The socket is placed on a mandrel containing a die, and the slot is punched out except the portion through the arch. *Second boring*—The socket is bored up nearly to its true size. *Second turning*—The exterior of the socket is turned down except at the arch. *First milling socket*—The ragged ends of the socket are milled off and the length of the socket brought down to gauge. *Third turning*—The exterior of the socket is turned off at the arch. *Second punching*—The socket is punched through the arch. *Milling neck*—The neck is milled to shape and nearly to size. *Buffing neck*—The neck is buffed to remove roughness left by the milling-tools. *Grinding blade*—The back flutes of the blade are ground to give a smooth surface for polishing. *Filing slot*—The slot is filed to size for the front sight, after which the socket is milled. *Second milling*—This operation rounds the end of the socket next the blade. *Blocking*—The bayonet-clasp is roughly blocked from an iron bar, the cross-section of which is .625 inch by .312 inch, by means of dies and a drop-hammer. *First trimming*—The central portion is punched out, and the fin at the sides trimmed off in a trimming-machine, which consists essentially of a die and punch. *Dropping*—The clasp is reheated, placed on a mandrel and swaged into a die under a drop-hammer. *Second trimming*—The fin around the arch and at the opposite end is trimmed off in a trimming-machine. *Annealing*—A number of clasps are placed in cast-

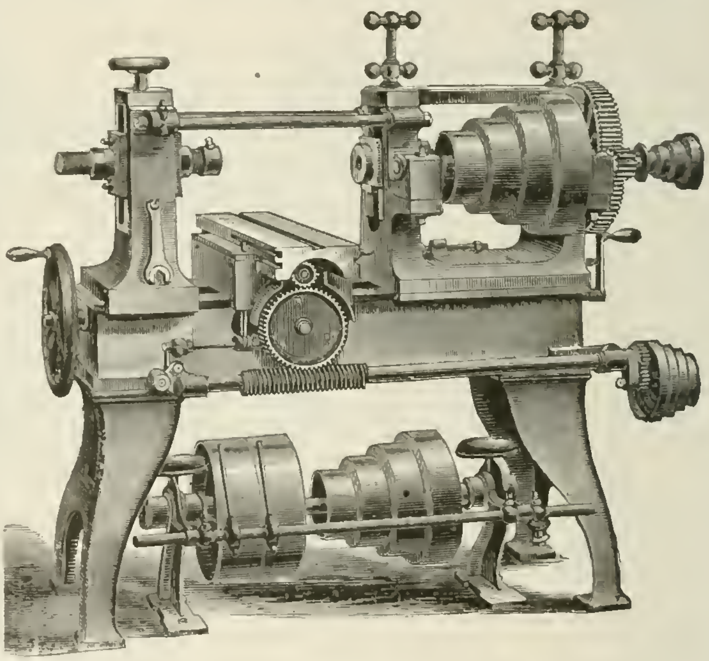


Fig. 3.

iron retorts in alternate layers with fine charcoal, and covers are fastened on with brick-clay. Several retorts are placed in an annealing-furnace, charcoal is packed between and over them, a fire started, and the retorts brought to a red heat. The charcoal having burnt away, the retorts cool gradually, remaining in the furnace about 24 hours. The clasps are then soft enough to be easily turned, milled, etc. They are then vitrioled. *Turning*—The clasp is placed on a mandrel having an arbor or shaft by which the mandrel is held in a turning-lathe. Cutters pressing against each side of the clasp trim off the fin around it left by the die in dropping. *Pressing*—The clasp, again placed on a mandrel, is cold-pressed into shape and thickness to avoid milling the sides.

First cutting—A length amply sufficient for a ramrod is cut from a cast-steel bar, .28 inch round, by a pair of heavy shears. *First straightening*—The piece cut off is straightened on an anvil with a hand-hammer. *First grinding*—The rod is now ground to a uniform size on a grindstone. *First dropping*—One end having been heated, the rod is placed vertically in a clamp-vise and the heated end upset to form a head, by a drop-hammer. *Burring*—The burr formed by the edges of the vise is ground off on a grindstone. *First swaging*—The thickened end of the rod is reheated and the head formed in a die under a pony-hammer, the rod being turned slowly about its longer axis. *Second cutting*—The rod is again cut to a prescribed length, to act as a guide for determining the position of the swell. *Second dropping*—The portion near the head is heated and the rod upset in a clamp-vise, at the proper distance from the head for the swell for the ramrod-stop. *Second swaging*—The form of the swell is determined in a die under a pony-hammer, as explained for the head. *First annealing*—The rod from the head to the swell is brought to a red heat in melted lead and placed in wood-ashes, where it undergoes annealing, after which it is vitrioled. *Second straightening*—The rod is again straightened on an anvil with a hand-hammer. *First milling*—The head and about 3 inches of the body are now milled in a power milling-machine, shown in Fig. 3. The machine has automatic screw-feed, and stop motion adjustable at any point. *Second milling*—The head is next milled to form the flat. *Drilling*—Four small holes are drilled at right angles to the flat to form the slot. *Punching*—The slot is formed by a punching-machine, which easily removes the metal remaining between the holes already drilled. *Sizing*—The head is now brought to size in a clamp-milling machine. *Third milling*—The swell and body for about 2½ inches each side of the swell are milled in a clamp milling-machine. *Fourth milling*—About 4 inches from the swell are now milled to meet the grinding. *Fifth milling*—Same as third milling, except that it extends about 3½ inches each side of the swell. *Filing slot*—The slot is finished by hand-filing, which removes sharp edges left by the punch and rounds the corners. *Second grinding*—The rod is now ground to meet the fifth milling. *Tempering*—The rods, held in a pair of tongs, are placed in a long hollow fire and brought to a cherry-red heat. They are then plunged in a vat of brine, which renders them very hard and brittle. They are next coated with sperm-oil, and heated until the oil is burned off, when they are left with a spring temper. *Third grinding*—They are reground to remove the roughness produced in tempering, and to bring them more nearly to true size. *Sixth milling*—The small end is milled off, so that the rod is of the right length. *Second annealing*—About 4 inches of the small end are annealed precisely as before explained. *Third straightening*—The rod is straightened on an anvil after being annealed. *Seventh milling*—The grooves on the small end are formed in a clamp-milling machine. *First polishing*—The head is polished in a lathe with emery and oil. *Second polishing*—The rod is polished up to the milling, near the swell, in a vertical polishing-machine, in the same manner as explained for the barrel. *Third polishing*—The whole of the portion milled, except the head, is polished on a buff-wheel. The jointed ramrod for the carbine is comprised of three sections of equal length of 8½ inches. The first section has the *stem*, *head*, and *screw*. The second and third sections have the *stem*, *swell*, and *screw*. The swells on the end of these two sections are drilled and tapped to receive the screw-ends of the first and second sections which make the complete rod. The material of which this ramrod is made is cast-steel. *Forging*—The end of the rod, which is round, is upset sufficiently to form the head, and then drawn and rounded under a small tilt-hammer to the proper size and length. *First-straightened*—This is done by hand, while cold, on an anvil. *First-annealed*—Annealed in cast iron retorts by packing in charcoal-dust and heating in a furnace to a cherry-red heat for five or six hours, after which the furnace is allowed to cool slowly. *First-milled*—The first milling is done in a clamp-milling machine, which forms the *head* and *stem* about 3 inches to nearly the right size. *Second-milled*—The rod is then reversed and the remainder of the stem is milled in another set of clamp-milling dies. *Third-milled*—This operation clamp-mills the entire section to its finish-size in dies that receive both the head and stem at one operation. *First buffed*—Buff-polished on a revolving emery-wheel to remove the roughness and prepare it for tempering. *Tempered*—Heated to a cherry red and hardened in water; then it is drawn over a blaze to a spring temper, and second-straightened. *Second-annealed*—The point of the rod is now annealed about half an inch for cutting the thread. *Fourth-milled*—Clamp-mills about half an inch of the end to the proper size for cutting the thread that screws into the other section. *Cut*—The thread is made in the

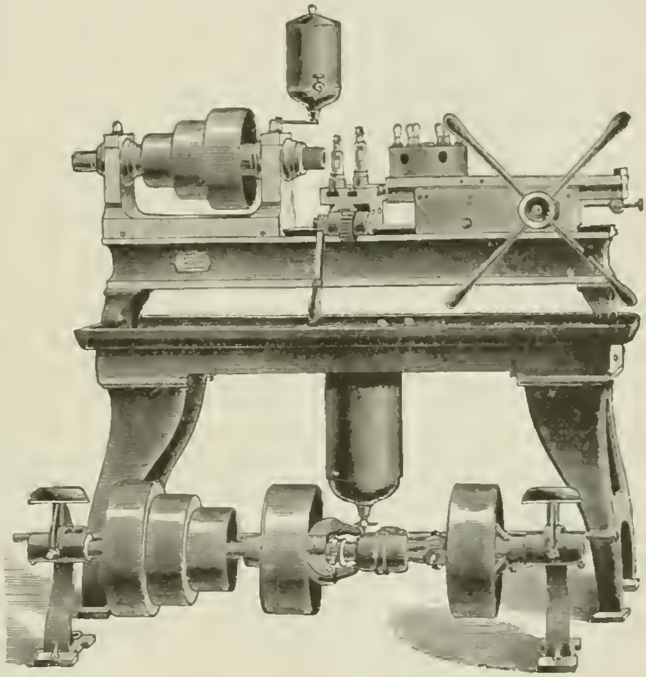


Fig. 4.

screw-cutting machine, shown in Fig. 4. *Second-buffed*—Polishes the head of the rod on an emery-wheel. The drilling and tapping on the second and third sections is done on a screw-milling machine and tapping-machine which drills into the *swell* about half an inch, then taps the hole to receive the screw-end of the other section; the other operations are the same as specified in the first section. The ramrod-stop is formed from a steel rod .57 inch in diameter. One end having been heated is drawn out to give more stock at the ends of the stop in a die under a trip-hammer, after which it is returned to the fire. Four rods are usually worked at the same time. Each one having undergone the above operation, the first one is taken from the fire, transferred to a drop-hammer, and the forging completed by a single blow. It is then *annealed*, *vitrioled*, and *trimmed*.

The following operations are necessary for the mountings and small parts: The *butt-plate* is blocked from a bar by being forced in dies by a single blow from each of two drop-hammers. The fin around the edge is trimmed off by a trimming-machine. The plate is well heated and placed under a drop-hammer which bends it and at the same time swages it into shape in a die. It is then *annealed* and *vitrioled*, after which it is *cold-dropped*, that is, forced while cold in a die by a drop-hammer. *Forging*—The screws are forged from a rod .57 inch in diameter in a die under a pony-hammer. *Annealing*—They are then *annealed* and *vitrioled*. The *rear-sight base* is partially formed from a bar, the cross-section being .562 inch square, in a die under the drop-hammer. *Annealing*—It is next *annealed, vitrioled*, heated and *dropped;* then *annealed, vitrioled*, and *trimmed*. The *rear-sight base-spring* is forged in a die under a drop-hammer from a cast-steel bar .375 inch by .125 inch, after which it is *annealed, vitrioled*, and *trimmed*. The *rear-sight leaf* is partially formed from a bar, the cross-section of which is .438 inch by .50 inch, in a die under a pony-hammer. It is then transferred to a drop-hammer, where the forging is completed by a very heavy blow. It is then *annealed, vitrioled*, and *trimmed*. The *rear-sight slide* is formed from a bar .31 inch square precisely as explained for the rear-sight-base spring. The bar from which the *front sights* are formed is first rolled to bring its cross-section to the form of the cross-section of the sight. A piece of sufficient length for the sight is cut from the bar by a punching-machine, after which the sides and bottom of the pieces are milled nearly to size. Subsequent operations relating to the sight are explained in connection with the barrel. The *guard-plate* is partially brought to form from a rod .57 inch in diameter under a trip-hammer. It is then heated and *dropped, annealed*, and *vitrioled*. The *guard-bow* is blocked from a rod .48 inch in diameter; then *dropped, annealed, vitrioled*, and *trimmed* in the manner explained for the guard-plate. The *guard-bow swivel* is formed from a rod .28 inch in diameter. A portion sufficient for the swivel is drawn out under a pony-hammer, leaving stock at both ends to form the pads, and afterward cut from the rod. The piece having been reheated is placed in a foot-vise and the pads formed by a hand-hammer. It is then *annealed* and *vitrioled*. The *hammer* is made as follows: The heated end of a bar, the cross-section of which is 1.13 inch by .5 inch, undergoes a drawing-out process in a die, under several blows from the drop-hammer. While still hot, the end thus roughly prepared is placed under another drop-hammer and forced in a die by a single blow. It is now returned to the fire. The workman usually has four bars in the fire at the same time, all of which undergo the above operation in succession. The first one is now taken from the fire, the heated end placed under the drop-hammer last used, given a single blow, immediately afterward placed in a trimming-machine, when the fin surrounding is cut off, placed under another drop-hammer and forced into a die by a single blow, which brings the hammer nearly to shape and at the same time cuts it from the bar. The fin or surplus metal forced out by the dies is removed by the trimming-machine. The hammer is reheated and dropped in a die smaller than those used before. It is then *annealed, vitrioled, second-trimmed*, and *cold-pressed*. The cold-pressing is for the purpose of giving a smooth, compact surface, and to save milling the body. In making the *lock-plate*, a flat bar of decarbonized steel, the cross-section of which is 1.75 inch by .22 inch, is *annealed* in charcoal, after which the plate is punched out by a punching-press. The *main-spring* is partially formed in a die under a pony-hammer, from a cast-steel bar, the cross-section of which is .31 inch square. It is then heated and *dropped, annealed*, and *vitrioled*. The *main-spring swivel* is forged from a cast-steel rod, .375 inch by .125 inch, in a die under a drop hammer. It is then *annealed, vitrioled*, and *trimmed*. The *tumbler* is roughly formed from a cast-steel bar, the cross-section being 1 inch by .38 inch, in a die under a trip-hammer. It is next heated and *dropped*, then *vitrioled*. The *bridle* is partially formed from a bar, the cross-section of which is .47 inch square, in a die under a drop-hammer. It is then *trimmed*, heated and *dropped*, and again *trimmed*. The *sear* is formed from a cast-steel rod, .313 inch by .25 inch, precisely as explained for rear-sight base-springs. The *sear-spring* is partially formed from a cast-steel bar, .32 inch by .18 inch, in a die under a drop-hammer. It is then *trimmed* while hot and the forging completed. It is in order *annealed, vitrioled*, and *trimmed*. The *upper band* is formed from a bar, .75 inch by 3.75 inches, in a die under a drop-hammer. The surplus stock (central portion and outside fin) is removed by a trimming-machine. The band is reheated, placed on a mandrel, and forced in a die by a drop-hammer. It is then *annealed* and *vitrioled*. The *lower band* is blocked, trimmed, *dropped, annealed*, and *vitrioled*, precisely as explained for the upper band. It is next

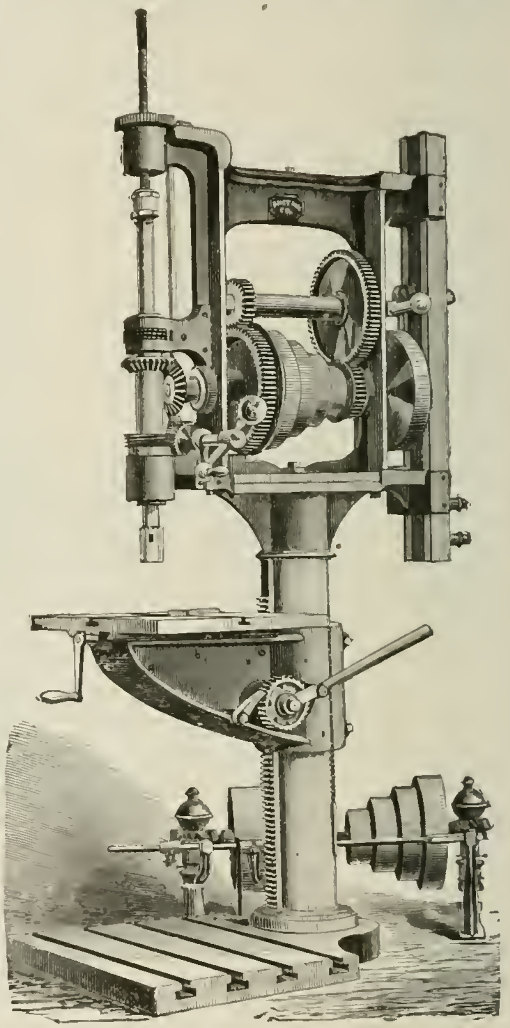


Fig. 5.

placed on a mandrel in a turning-lathe, and the fin at the edges turned off, in the manner explained for the bayonet-clasp. It is then reheated and dropped on a mandrel to bring it to the right thickness, after which it is edged, or the fin at the edges turned off. It is driven while cold on a mandrel-gauge, which serves to give it the required taper. It is also stamped with the letter U. The *band-springs* are formed from a cast-steel rod, .108 inch square, in a die under a drop-hammer. They are then *annealed, vitrioled, trimmed*, and *cold-dropped*. The *side-screws* are forged from a rod, .438 inch diameter, in a die under a pony-hammer. They are then *annealed* and *vitrioled*. The *side-screw wash-*

ers are forged from a bar, the cross-section of which is .313 inch by .563 inch, in a die under a drop-hammer. Eight or ten are forged on a single strip. They are then *annealed* and *vitrioled*. The *breech-screw* is forged from a bar, .75 inch square, one end of which is heated, placed under a drop-hammer and forced in a die by a single blow, which partially forms the screw. The fin around it is removed by a trimming-machine, after which the screw is forced in a slightly smaller die by one blow from another drop-hammer. One heat suffices for the forging. It is then *annealed* and *vitrioled*, after which it is *trimmed* in a trimming-machine; that is, forced while cold through a die by a punch which removes the fin. The *breech-block* is roughly formed from a bar, 1.30 inch by .75 inch, cross-section, by being forced in dies by a single blow from each of two drop-hammers. It is then *vitrioled*, *first-trimmed*, then heated and *dropped*, after which it is *annealed*, *vitrioled*, and *second-trimmed*. The *breech-block cap* is brought to shape in a die by a single blow from a drop-hammer, after which it is *annealed*, *vitrioled*, and *trimmed*. The *thumb-piece* is roughly formed from a bar, 1.31 inch by .38 inch, cross-section, in a die under the drop-hammer. It is then *trimmed* and *vitrioled*, heated and *dropped*, after which it is *annealed*, *vitrioled*, and *second-trimmed*. The *cam-latch* is formed in a die, under a pony-hammer. It is then *dropped*, *annealed*, *vitrioled*, and *trimmed*. The *extractor* is forged from a cast-steel rod, .31 inch square, in a die, under a drop-hammer. It is in order *annealed*, *vitrioled*, and *trimmed*. The *hinge-pins* are partially formed in a die, under a pony-hammer, after which they are transferred to a drop-hammer and the forging completed. They are made from cast-steel rods, .28 inch in diameter. They are in order *annealed*, *vitrioled*, and *trimmed*. The *tang-screws* are forged from a bar .4 inch in diameter; then *annealed* and *vitrioled* in the manner explained for the side-screws. The *receiver* is roughly formed from a bar, the cross-section of which is 1.25 inch square, one end of which having been heated is forced into a die by a single blow of a drop-hammer. It is immediately transferred to another drop-hammer, where it receives one blow, which completes the blocking and cuts the receiver from the bar. It is *trimmed*, then heated and *dropped*, *vitrioled*, *second-trimmed*, and *second-dropped*. Immediately after the *second dropping*, while still hot, the receivers are imbedded in fine charcoal in cast-iron boxes in the same manner as explained for barrels. In about three days they are sufficiently cool to be removed, when they are also soft enough to be easily drilled, milled, etc. They are then *vitrioled* and *third-trimmed*.

From the forging department, the parts are taken to the milling and filing departments, and finally to the assembling department. Many of the parts are subjected to a variety of operations. The object of *drilling* is to form holes for the screws, rivets, etc. Fig. 5 represents a combined drill and slotter, made with a double table and operated two ways, in and out from the column and crosswise at the same time. By this arrangement pieces can be fastened to the table and moved to different positions under the operating spindle without loosening the work from the table. By having drills suited to the operating spindle, this machine can be used for milling irregular forms, such as is usually done in a regular die-sinking machine. The object of the tapping is to convert the surface of the hole into a female screw. This operation is performed by an instrument called the *tap*, which is formed of a piece of steel, of a pyramidal shape, and upon the edges of which are segments of screw-threads. In all operations of cutting and drilling wrought-iron, it is necessary to use oil or water to preserve the temper of the tools. In working cast-iron, no cooling substance is required. The object of *turning* is to give shape and smoothness to the exterior of a body, which is accomplished in the *lathe* (Fig. 2). The body is generally made to revolve around a fixed axis, and a cutter, which has a motion parallel to this axis, is made to press against its surface; the combination of these two motions cuts away a spiral chip, and leaves a new surface concentric with the axis. It will be easily seen that if the cutter has, in addition to its motion parallel to the axis of rotation, another perpendicular to it, the resulting figure will be no longer round, but irregular. This constitutes the principle of *eccentric turning*, and affords the means of turning an almost infinite variety of shapes, simply by regulating the motion of the cutter by a pattern, or model of hardened steel. In this way gun-stocks, and other irregular figures, are formed by machinery; the principle has even been used in copying statuary. Pieces of metal which are not suited to the turning-lathe may be reduced to their proper shape by *milling*, an operation adapted to nearly all surfaces which have right-line elements. It is performed by a revolving cutter, armed with saw-teeth, while the piece to be cut is fastened on a carriage, which moves steadily under the cutter, and along a plane director. See Figs. 1

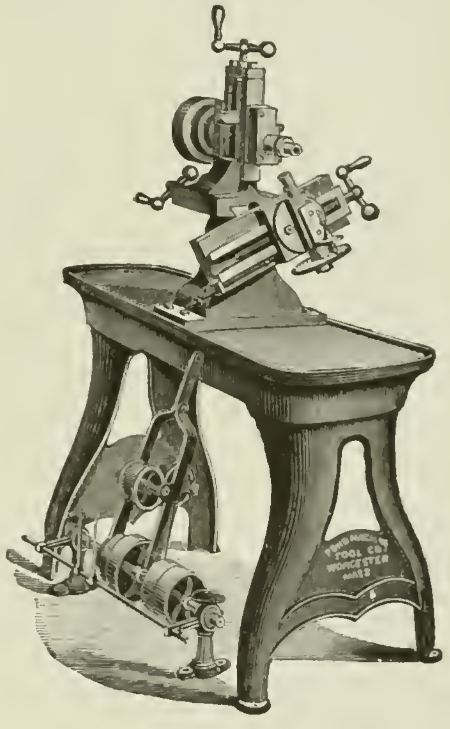


FIG. 6.

and 3; also article MILLING. Fig. 6 represents the index milling-machine, which is applicable to a great variety of light work, such as milling, slabbing, gear-cutting, cutter-making, and profiling. The cross-bar is secured to the foot of the upright, below the horizontal spindle and at a right angle with it, by a large bolt which passes through the upright. The index-spindle, of steel, is mounted vertically in a long bearing on the swivel-plate, which plate is also graduated on its periphery to mark its angle on the cross-bar saddle, to which it is secured by two bolts, and has an index-plate on its lower end, in any one of the holes in which the steel point may be inserted to hold the spindle, while cutting any piece that may be inserted in the tapering hole in the upper end of this spindle, or held in a small vise, chuck or centers on which a suitable hub is cast, bored and provided with screws to secure them to the upper end of the spindle. This machine will cut small gears (to 6 inches diameter) either spur or bevel, or cutters, mill-taps and reamers, straight, taper, or spiral, slab-nuts, slot screw-heads, saw, drill, or profile small parts or fixtures, and steel tools and jigs of all kinds. *Cutting* and *filing* are done by the hand—the former with a cold-chisel, and the latter by a file. They are employed to finish such parts as are not well adapted to machinery. To guide the workman in giving the proper form, the piece is placed in a hardened steel frame, called a *jeg*. *Grinding* is done with rapidly-revolving grindstones, and is principally confined to finishing the bayonet and the exterior of the barrel. *Polishing the surface* of finished parts is done with emery-wheels, which revolve with great rapidity. The wheels are made of wood, and the circumference is covered with buff-leather, to which is glued a coating of emery. *Case-hardening* is the conversion of the surface of wrought-iron into steel, to enable it to receive a polish or bear friction. The process consists in heating the iron to a cherry red, in a close vessel, in contact with carbonaceous matter, and then plunging it into cold water. Old shoes are generally employed for this purpose at the armories, although bones, hoofs, soot, etc., will answer. The materials should be first burnt, and then pulverized. *Hardening* is effected by heating the steel to a cherry red, or until the scales of oxide are loosened on its surface, and plunging it into a liquid, as water, oil, etc., or placing it in contact with some cooling solid; the degree of hardness depends on the heat and the rapidity of cooling. Steel is thus rendered so hard as to resist the hardest file; and it becomes at the same time extremely brittle. In its hardest state steel is too brittle for most purposes; the requisite strength and elasticity are obtained by *tempering*, which is done by heating the hardened steel to a certain degree and plunging it into cold water. The requisite heat is usually ascertained by the color which the surface of the steel presents, due to the film of oxide formed on it:

At 450° Fahr., a pale straw-color.	Suitable for hard instruments, as the faces of hammers, etc.
At 600° Fahr., a grayish blue.	Gives a spring temper, or one that will bend before breaking: suitable for saws, sword-blades, etc.

Shades of colors between these extremes give intermediate degrees of hardness. If steel be heated above 600°, the effect of the hardening process is destroyed. The parts of small-arms are tempered by dipping them in oil, then heating them until the oil is burned off, when they are again plunged into cold water. A blue color is given to the surface of iron or steel parts by heating them till the desired shade appears, when they are removed and allowed to cool gradually, by which the color becomes fast. The barrel and the bayonet, to protect them from the action of the atmosphere and to prevent the surface from reflecting the sunlight, are browned, or covered with a coating of rust. This is accomplished by a mixture of such materials as *tincture of iron*, *spirits of wine*, *nitric acid*, etc., which being applied to the clean surfaces produces a coat which is then well rubbed with a *steel scratch-card* until it has a metallic luster. This operation is repeated till the desired color is obtained. See *Drop-hammer*, *Emery-grinder*, *Milling*, *Rifling*, *Royal Small-arms*, and *Small-arms*.

FABRICATION OF PROJECTILES.—*Shot* and *Shells*, depending upon their kind and size, should be made of gray or of mottled cast-iron, of good quality. Those that are large and required to possess great strength should be of "gun-metal," melted in an air-furnace For ordinary projectiles mottled iron is used; it is obtained by melting, in a cupola-furnace, a mixture of white and gray pig-irons. *Shrapnel* must be made of the best quality of iron, and with peculiar care, in order that they may not be liable to break in the piece. *Grape* and *Canister* should be of soft gray iron, brought to a very fluid state before casting. *Chilled shot* are cast from a special mixture of irons, melted in a cupola-furnace.

All projectiles should be cast in sand and not in iron molds, as those from the latter are seldom uniform in size or shape, are liable to contain cavities, and are cracked if heated. Sand possessing all the properties to be desired for molding is seldom, if ever, found in a state of nature. But, when the requisite qualities are known, the materials may be selected and an artificial composition produced without difficulty. The sand should be silicious, refractory, and of an angular grain of moderate size. The degree to which the first and second qualities should be possessed depends upon the size of the casting; the sand must not be fused or even softened by the heat to which it is subjected. The angular form and large size of the particles increase the resistance of the mold, though rendering it less compact; this last facilitates the

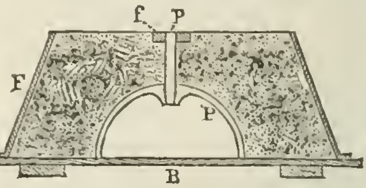


Fig. 1.

evaporation of the moisture in drying, and permits the escape of the gases formed in the material of the mold by the heat of the fused metal. Pit- and not river-sand should be used, as the latter is not sufficiently sharp or cohesive.

The molding composition must contain such an amount of clay that, when slightly moistened, it will retain its shape when pressed in the hand; it must become hard when dried that it may not lose the form given it, and must possess the consistence necessary to resist the pressure of the liquid metal. As clay contracts by heat, an excess of it will cause cracks in the mold in drying. The manner of preparing the composition is usually to mix fire-sand and loam or field-sand, to sift it carefully, and then to moisten it with water in which clay has been stirred. The particular sand to be employed, and the proportion of clay to be introduced, depend upon the size of the casting.

Spherical Projectiles.—Case-shot, shell, and all solid shot smaller than the 15-inch are cast singly. Fifteen- and twenty-inch solid shot are usually cast in clusters of five and three respectively. When cast singly the pattern of a spherical projectile is composed of two hol-

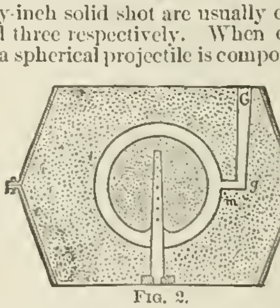


Fig. 2.

low cast-iron hemispheres, uniting in such a manner as to form a perfect sphere; on the interior of each hemisphere is a handle by which it is withdrawn from the sand after molding. The flask has neither top nor bottom, or has movable ones; it is usually in two parts, joining in the same plane as the pieces of the pattern. In molding a *shell* (Figs. 1 and 2), the *pattern*, P, of that half in which is situated the fuse-hole is placed with its flat side upon the *molding-board*, B; this is covered with its corresponding half of the *flask*, F; the *spindle* (*p*), attached to the pattern, passes through a hole in the *cross-piece* (*f*) of the flask. Powdered charcoal or fine dry sand is sprinkled over the board and pattern, to prevent the fresh sand from adhering to these surfaces. The molding-sand is then introduced gradually into the flask being well rammed as it rises up about the pattern. When completed, this portion of the flask with its contents is turned over on a board, the other half of the pattern placed upon that already in position, and the second part of the flask laid on the first and properly fitted thereto. The pattern and the exposed surface of the mold are sprinkled as before, and the molding continued, a conical stick having first been so placed as to form the "*gate*," G, for the introduction of the molten metal. The flask having been filled, the two parts are separated; each now contains one half the mold with the corresponding part of the pattern. The stick for the gate is withdrawn from the outside, and the hemispheres are extracted from the inside. A channel is cut in the plane surface from *g* to *m*, so that the metal, entering at G, may be carried to the mold-cavity at a point where it can flow into place without injury to the surface of the sand. Any imperfections are at this time repaired. The whole interior surface is then coated with a wash of powdered coke and clay-water, after which the mold is thoroughly dried in an oven. This wash gives a smooth, hard surface to the sand, which insures a smooth casting.

The core is formed about a hollow iron spindle, perforated with small holes through which escape the steam and gases generated by the heat of the metal. The core is centered in the mold by means of a gauge, and is supported in that position by the spindle which forms the fuse-hole. The spindle is perforated with small holes to allow the escape of steam and gas generated by the heat of the melted metal; that part of it which forms the fuse-hole is coated with sand to prevent adhesion. When the ears for the shell-hooks are cast in the projectile the necessary projections for their formation are placed in position before drying the mold. In pouring the melted iron into the mold with the ladle, care should be taken to prevent scoria and dirt from entering with it, and for this purpose the surface should be skimmed with a stick of wood. After the iron has become sufficiently hardened the flask is removed, the spruehead is broken off, and the composition scraped from the outside of the casting. The core is then broken up and removed, and the interior surface cleaned by a scraper. The projection at the gate and other excrescences are next chipped off and the surface of the projectile is smoothed in a rolling-barrel, or with a file or chisel if found necessary. The fuse-hole is then reamed out to the proper size and the projectile is ready for inspection.

When shot are cast in clusters, the pattern is made of wood and consists of two longitudinal halves, which are fitted with iron pins or dowels so that they can be accurately joined together for the construction of the mold. The cluster is cast with a sinking-head to feed the shrinkage, while the shot are made with a diameter slightly in excess of the required one, to permit of their being turned down and finished. The flask is also made in two equal parts or sections which are united by bolts. The back of each section is fitted with movable plates, to admit of the introduction of the molding composition. To form the mold, one half of the pattern is laid upon the molding-board, together with the pattern for one half of the channel for the metal, both being held in place by dowels. A section of the flask is then placed in position over the patterns, and the intervening space is filled with molding composition, which is firmly rammed down, the patterns for the branches to the channels being introduced as the work progresses. The plates are then attached in their places. To form the other section of the mold, the finished one is removed from the molding-board and turned over, the remaining halves of the patterns and flask are placed in position upon it, and the molding composition filled in in the same manner. A layer of dry sand is first sprinkled over the surface of the finished section to prevent adhesion. The mold being completed, the two sections are separated and the patterns withdrawn. After being thoroughly dried in an oven and receiving a coating of coke wash on the interior surface, the sections are united and firmly secured together with bolts and nuts. The mold is then ready for the casting and is lowered into the pit. Several clusters are usually cast with one heat of metal, the number depending upon the capacity of the furnace. The casting is usually allowed to remain in the pit for twelve or fifteen hours after the pouring of the metal, when it is hoisted out and taken from the flask. After it becomes cool it is freed from the adhering composition and the gates are broken off.

To separate the shot in the cluster, the latter is placed in a lathe, shown in Fig. 3, the sinking-head being secured in the chuck at the head of the machine, while the other end is supported by a movable center which slides upon the ways. When the cluster is properly centered, the necks which connect the shot are turned down as small as it is safe to make

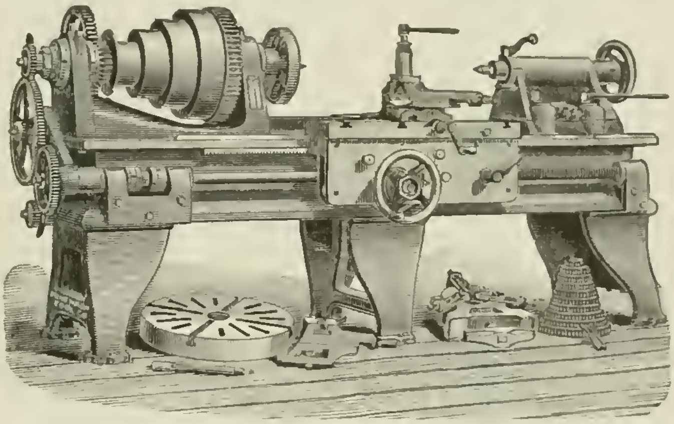


Fig. 3.

them without risking the breaking of the cluster in the lathe. The neck nearest to the bottom is then carefully turned down until it begins to show indications of breaking. The cluster is then chocked up by placing blocks between it and the lathe-bed, the center is slid back, and the shot is broken off by blows with a hammer and removed. The cluster is then recentered in the lathe, and the shot are successively detached in a similar manner until all are separated. Care should be taken to preserve, as far as practicable, a spherical form to that portion of the surface where the neck is turned away. The small portions of the necks which remain after the separation are chipped off by hand. The shot is next turned down to the required diameter and given a smooth and finished surface. The tool-rest of this lathe is attached to a geared wheel, which is pivoted in a horizontal position upon an iron frame secured to the lathe-bed. The motion of this wheel by means of a feed causes the edge of the tool to move on the arc of a circle, its distance from the center of the circle meanwhile being regulated by a screw in the base of the rest. The shot is centered in the lathe by means of a square-headed screw in the axis of the wheel. In turning the shot it is made to revolve upon that diameter which coincides with the axis of the lathe, while the movement of the tool-rest, as above described, brings the tool in contact with all of the surface which is not covered by the supports. In this position the shot is finished as far as practicable, and is then recentered so that the unturned portions of the surface can be brought in contact with the tool, when they are finished in like manner. The ears for the shell-hooks are then drilled in a drilling-machine and the shot is ready for inspection. Fifteen- and twenty-inch shell are sometimes cast above size and finished in the lathe in the same way as cluster-shot.

Elongated Projectiles.—The same principles are followed in the different operations attending the fabrication of elongated as of spherical projectiles. The shape and construction of the flask and pattern depend upon the particular form of the projectile, the system to which it belongs, and the object for which it must be employed. The construction applied in the fabrication of a Parrott shell is shown in Fig. 4; the flask and pattern are each in two parts, united along the plane (*f*, *f*); the *ring* (*m*), of molding-sand, is made in a special box; and is inserted when the mold is assembled before casting, and is necessary to give the shape peculiar to that system of projectiles. The *spindle*, S, as in all the large oblong shells, passes entirely through the *core*, C, and is secured at both ends to the flask, or to the mold. The metal is taken from the cupola into the ladles, and, in the case of chilled shot, usually slightly cooled by throwing in a piece of scrap-iron. This is done to prevent the chill-molds from being cracked. The metal enters the mold from below, near and above the chill-mold, and (from the shape of the lower branch of the "feeder") in an oblique direction, to avoid disturbing the core and to give a circular motion to the metal as it rises in the mold, and so prevent the scoria from adhering to the sides. One workman skims the surface of the metal with a wooden stick, as it runs from the ladle, to prevent the admission of the scoria, while another stirs it as it rises, with an iron rod, through the "riser," to bring the impurities to the surface. Before fairly cooled the flasks are removed, the sand knocked off, the core-stem extracted, and the shot left to cool in the heated sand in which it was cast. The sand is now carefully scraped from the cavity, the sinking-head is removed, and the rough edges trimmed off with a cold-chisel. It is then examined as to quality and weight, and the amount of eccentricity roughly determined. The shot is at once condemned if there be a variation in any of these particulars in excess of that allowed. It sometimes happens, too, that the chill has extended so far over the surface as to make it impossible to finish the shot by the means ordinarily employed in this country. Such shot are, however, sometimes finished by the grindstone. Having passed this preliminary inspection, it is put in the lathe and turned down to the true diameter for the length of .25 inch. The shot is finally passed through the *finishing-press*, and placed in a lathe where the base is finished; if the Butler sabot is to be used, a screw-thread is cut upon the base. The sabot is usually formed of an alloy of 70 parts copper and 30 of zinc. It is either cast separately or directly upon the base of the projectile; in the former case it is bored and turned to the finished size. The shot is completed by tapping a thread on the screw-plug hole, fitting it with a plug, and screwing or casting on the sabot. See *Core-box*, *Finishing-press*, and *Projectiles*.

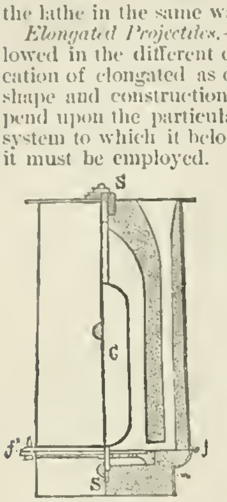
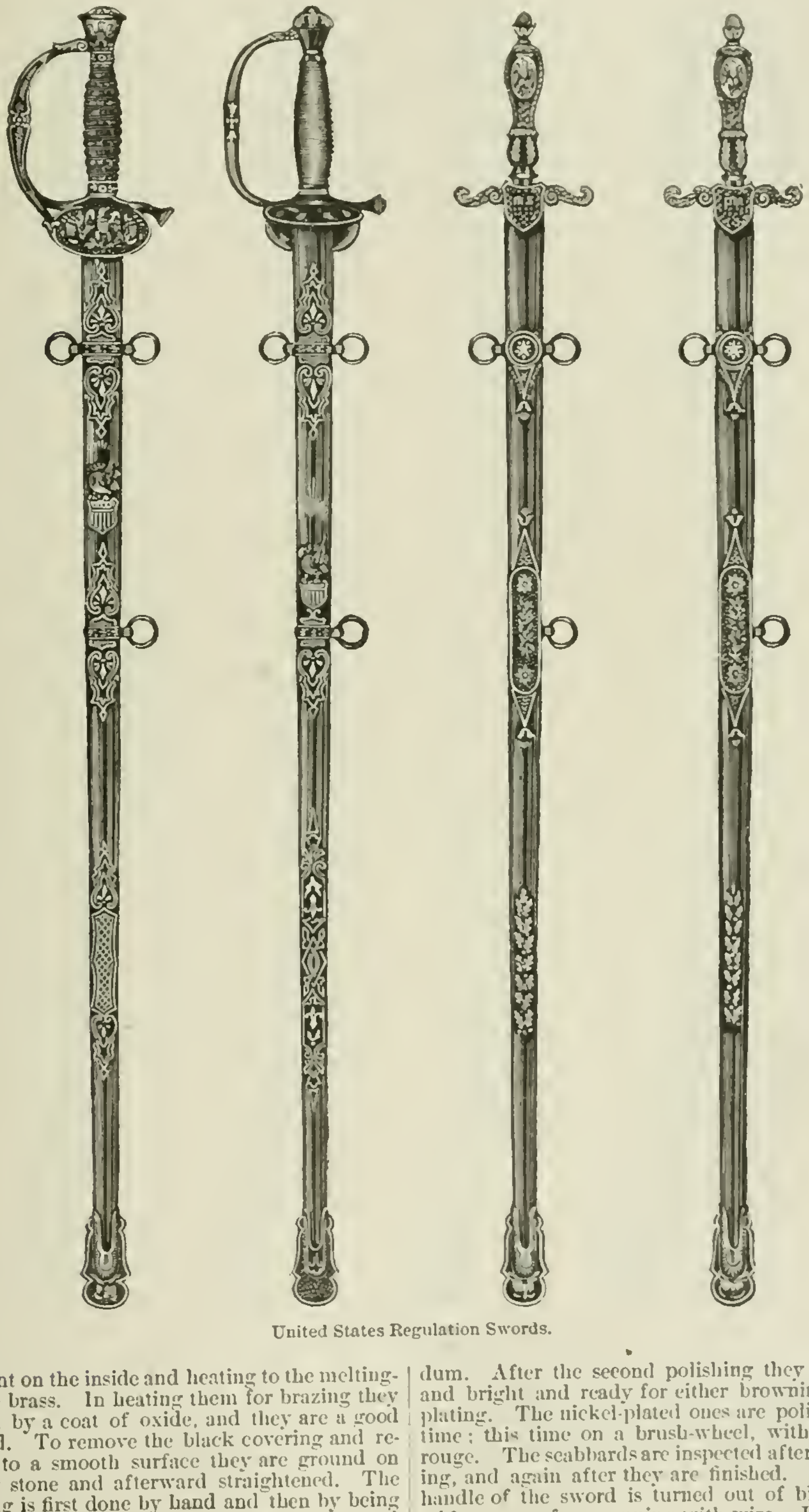


FIG. 4.

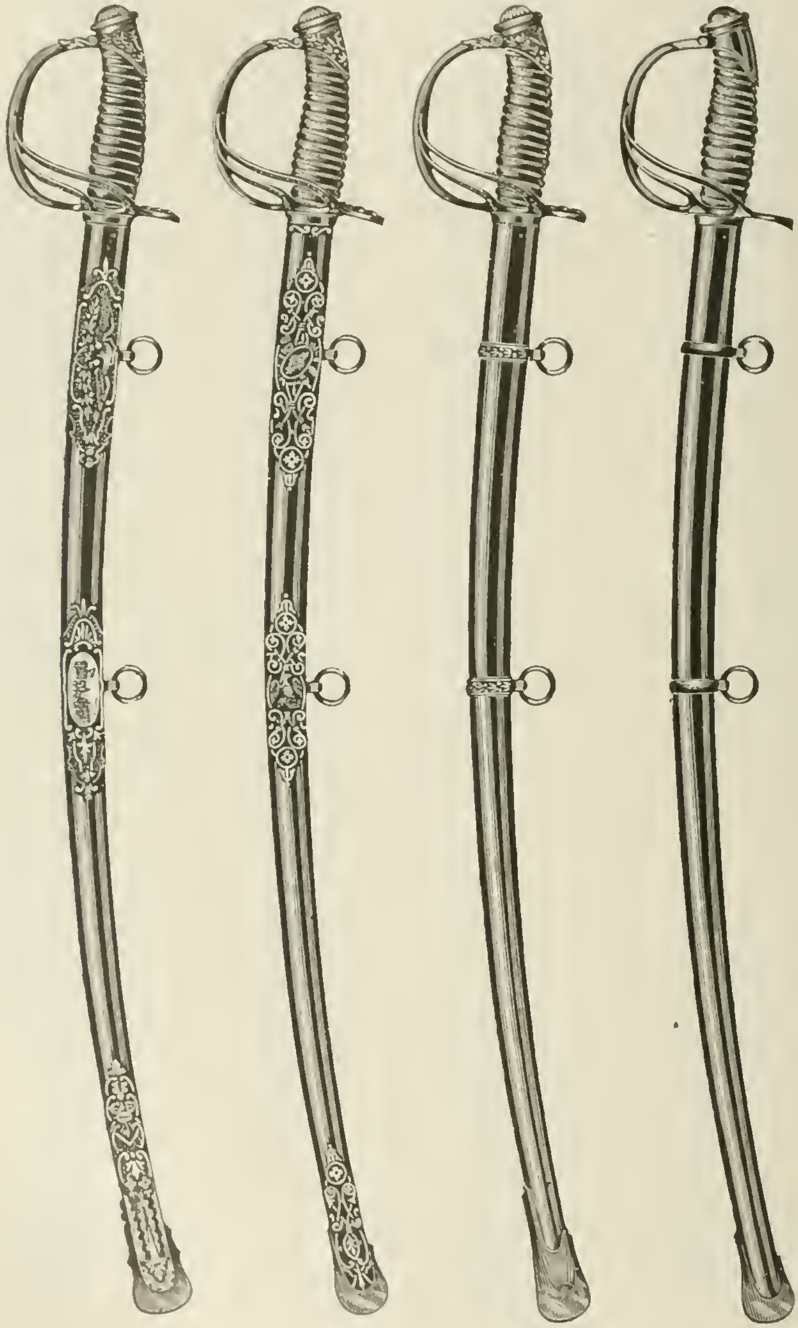
FABRICATION OF SWORDS AND SABERS.—The complete sword consists of the *blade*, *scabbard*, *gripe*, and the *mountings*. The blade is made of the best English cast-steel; the skelp, which is $8\frac{1}{4}$ inches in length, being cut from a square $\frac{5}{8}$-inch bar. The principal operations in making the blade are forging, milling, tempering, grinding, polishing, and etching. The first operation of *forging* consists in drawing out the skelp to nearly the required length of the finished blade, and is done under the tilt-hammer. The second operation, also under the tilt-hammer, draws it out to a little longer than its finished length and shapes it, forming an arris on each side. The *tang*, of wrought-iron, is then welded on, and shaped under a *drop*. After the forging the blade is straightened by hand while cold. To reduce the tang, shoulder, and the portion of the blade immediately adjoining the shoulder to the proper shape and dimensions, they are *milled*. Four different cuts are necessary. At this point the edges of the blade are ground on a revolving stone, to near their required shape, so as to serve as a guide in future grinding operations. The blade is set in a fixture for the purpose. The operation is known as first-edging. The blade after being forged is soft and flexible, and it is necessary to give it a certain degree of hardness and elasticity, which is done by *hardening* and *tempering*. The success of this operation depends greatly on the skill of the workman and his ability to detect by the eye the temperature best suited to the steel used. To harden the blade the workman holds it in the heat of a charcoal-furnace, moving it back and forth to heat the several parts uniformly. When its color is a cherry-red it is withdrawn and plunged into cold salt-water. It is now very hard and brittle, and generally warped. It is therefore necessary to straighten and partially anneal or temper it. To effect this it is again heated; this time to only a blue heat. While thus heated it is soft and can be straightened, which is done quickly, and it is then plunged into cold water as before. This gives it the proper degree of hardness and elasticity. After being tempered the blade is *ground* on rapidly revolving coarse grindstones to reduce all parts to the proper size. Two grindings are necessary: the first extending to the cross-grinding of the whole blade, except the point by which it is held in the fixture; and the second on a finer grindstone, where the point is shaped and the whole blade ground lengthwise. The accurate dimensions are determined by proper gauge. The tang is fitted to a gauge by the file. The final grinding is that of the edges, known as second-edging, by which the edges are reduced to the required accuracy. By grinding, the blade is oftentimes bent and partially annealed. To correct these defects it is again heated to a blue heat, straightened quickly, and plunged into cold water, by which it is retempered. The object of *polishing* is to remove the marks of the grindstone and give it a smoother finish. This operation, done on a buff-wheel with emery or corundum, generally warps the blade, and makes a third straightening necessary. A second lighter polishing prepares it for *etching*—the process of marking the blade with ornamental devices. It is done by first painting the design on the polished blade with any varnish that will resist the action of diluted nitric acid. When this is dry the acid is applied with a woolen swab and attacks the parts of the blade left uncovered, leaving them in a rough or oxidized state, while the design remains smooth and bright. The varnish is dissolved off by spirits of turpentine, and the blade is cleaned with alcohol and whiting.

The *scabbard* is made of sheet-steel, thickness No. 19 Providence wire-gauge. The first operation is that of slitting or cutting the metal into strips of the proper size. These strips are first annealed and bent throughout their length into a gutter shape by means of a simple hand-machine known as a bending-machine. They are still further curved by being placed on a mandrel, clamped in a fixture on the bed of a planer, and passed under a wheel or roller attached to the tool-fixture of the machine. This finishes the shaping of the scabbard, which is elliptical in cross-section. The scabbards being very hard and brittle, to facilitate further operations they are at this point reannealed. The annealing is done by packing them in cast-iron retorts with powdered charcoal and ashes, and subjecting them to a red heat for five or six hours. They are then allowed to cool slowly, which renders them soft and flexible and easily worked. To produce good and accurate surfaces for brazing, the open joint of each is sawed through its entire length and the scabbards are again rolled on the planer. After being tightly wrapped with wire the scabbards are ready for brazing, which is done by placing a piece of brass wire without mandrel. After having the edges sawed up about 1¼ inch from the small end, for the better fitting of the ferrule, the scabbards are polished twice, being straightened after the first or rough polishing. The polishing is done on buff-wheels with emery or corun-



United States Regulation Swords.

over the joint on the inside and heating to the melting-point of the brass. In heating them for brazing they are covered by a coat of oxide, and they are a good deal warped. To remove the black covering and reduce them to a smooth surface they are ground on a revolving stone and afterward straightened. The straightening is first done by hand and then by being rolled on the planer; this time on both edges and dum. After the second polishing they are smooth and bright and ready for either browning or nickel-plating. The nickel-plated ones are polished a third time; this time on a brush-wheel, with crocus and rouge. The scabbards are inspected after each polishing, and again after they are finished. The *gripe* or handle of the sword is turned out of black walnut, with grooves for wrapping with wire. It is covered with shark-skin, glued on and blacked, and is then wrapped tightly with double brass wire. They are bored through from end to end to receive the tang of the blade, and fitted with a ferrule at each end. The *mountings* of hard bronze are made by casting in sand-



United States Regulation Sabers.

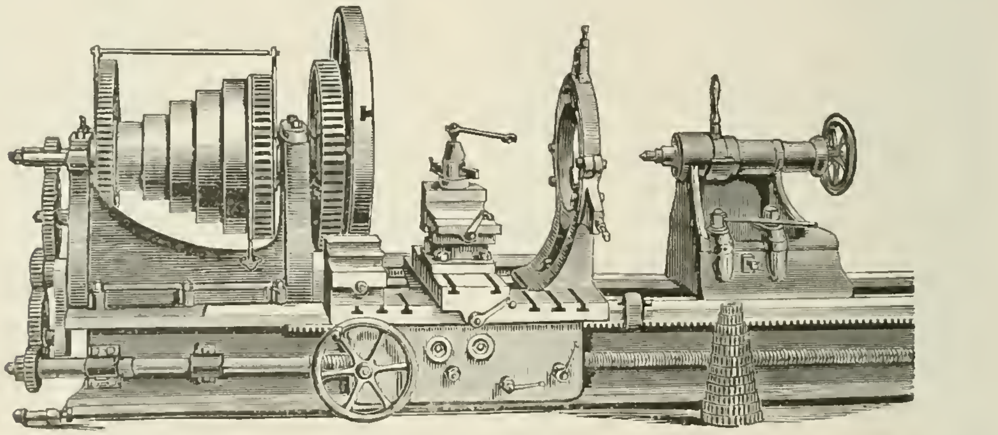
molds. They consist, for the blade, of the guard, crown-piece, and two ferrules for the gripe; and for the scabbard, of the mouth-piece, ferrule, and two bands, with rings for attaching to sword-belt. The guard has on the side next the wearer a hinged shell, held in place by a button and spring. The mountings are fitted in *sets*, gilt and burnished in the armory shops. The different parts being thus prepared, the swords are "assembled;" the mountings being accurately fitted to the blades and scabbards, and the scabbards lined on either flat side with a thin strip of pine, which extends about 15 inches from the mouth. They are finally examined by the Inspector, who selects the blades and scabbards suited to each other. The swords are issued with two scabbards, one browned and one nickel-plated, and are also supplied with chamois-skin cases.

The *bayonet-scabbard* is formed from sheet-steel, thickness No. 19 Providence gauge. The first operation is that of slitting or cutting the metal into strips of trapezoidal shape, 18.75 inches long, 2.53 inches wide at the larger and 1.5 inches wide at the smaller end. The strips are annealed by packing them in cast-iron retorts with powdered charcoal and ashes, and subjecting them to a red heat for 5 or 6 hours, and then allowing them to cool off slowly before exposing them to the air. These strips are first bent throughout their length into a gutter shape by means of a simple hand-machine known as a bending-machine. They are still further curved by being placed on a mandrel, clamped in a fixture or the bed of the planer, and passed under a wheel or roller attached to the tool-fixture of the machine. This finishes the shaping of the scabbard, which is elliptical in cross-section. To produce a good joint for brazing, the scabbard is placed in the planer and a circular saw is passed through its entire length; the scabbard is again rolled on the planer and the edges of the joint are brought into contact; a second annealing is required sometimes, if the steel appears too rigid and stiff to remain in the position bent. The *brazing* is done by first tightly wrapping the scabbard with iron wire to hold the edges of the steel firmly in contact, then placing a piece of brass wire on the inside over the joint and heating to the melting-point for brazing in the flame of a blow-pipe furnace. The operation of *buff-grinding* consists in grinding off the wire and brass which adhere to the scabbard after brazing, and is done on an emery or corundum wheel of the coarsest number. The scabbard is next finish polished, the entire surface, with fine emery or corundum. The operation of *browning* is the same as for rifle-barrels. The scabbard-spring is punched from sheet-steel, No. 19 Providence gauge, in a power-press, to the right length and width. The *curving* is done by heating the springs separately in a hollow oven, which is kept constantly at a red heat; when cherry-red the spring is taken out and replaced by another, with a pair of tongs, and curved in a clamp-vise to the right shape; it is allowed to chill before it is removed from the vise for another. The hole for the rivet is drilled in an upright power-press, the scabbard being held in a suitable fixture. The springs are packed in sheet-iron pans, edgewise, and heated in an oven to a red heat; then plunged into a tank of oil to harden them; then drawn to a spring temper in a sheet-iron pan by applying oil and moving the pan forward and back over the blaze of a charcoal-fire until the oil blazes off entirely, when they are thrown upon a table to cool off. The spring end that rides on the bayonet-blade to hold it is polished to prevent it from scratching the surface of the blade. The spring is *riveted* to the scabbard by hand with a suitable fixture for the purpose. The scabbard and spring are finally inspected: first, to see that the scabbard is properly browned of good body and color; second, to see that the spring is riveted firmly, and that it does not set when a bayonet-blade is inserted into the scabbard, and that the workmanship is good.

The proof and inspection of swords and sabers is conducted as follows: First. The dimensions and form of the blade are verified by comparing it with the model and by applying the appropriate gauges and patterns for the length, width, and thickness at several points, and the curvature, if any. Second. The blade is then proved as follows: 1. The point is confined by a staple, and the blade is bent on each of the flat sides over a cylindrical block, the curvature of which is that of a circle 35 inches diameter, the curvature of the part next the tang being reduced by inserting a wedge .7 inch thick at the head and 14 inches long. 2. It is struck twice on each of the flat sides on a block of oak wood, the curvature of which is the same as the above. 3. It is struck twice on the edge and twice on the back across an oak block 1 foot in diameter. 4. The point is placed on the floor and the blade bent until it describes an arc having the versed sine indicated in the appropriate table. After these trials the blade is examined to see that it is free from flaws, cracks, or all other imperfections, and that it is not *set*—that is, it does not remain bent. 5. See that a piece of iron is welded on the tang for riveting. 6. Observe that the pommel is properly countersunk for riveting tang. The blade of the artillery-sword is proved by striking each of the sides and edges twice on a flat block of hard oak wood. The stamp of approval or condemnation is placed on the side of the blade below the tang. Third. The form, dimensions, and workmanship of the *mountings* are examined and compared with the model. After the blade is mounted the sword is again examined, and it is struck four times on a hard block of wood to test the strength of the mountings. The quality of the brass mountings may be tested by breaking a certain number, not more than four in each hundred, which should be taken from the pieces rejected for erroneous dimensions. Fourth. The form, workmanship, and finish of the scabbards are examined and compared with the model and their fitting to the blades tested. The sewing of leather scabbards and the fastening of the ferrules and tips will be particularly examined. Steel scabbards are proved by letting fall on them from a height of 18 inches an iron weight of 2 pounds, 1 inch square at the base: 1st. On one side just below the upper band; 2d. On the same side 6 inches from the tip; 3d. On the opposite side just above the lower band. In this proof the scabbard should not remain indented. The nature of the material (whether iron or steel) may be tested, if there be any doubt, by using nitric acid, which will leave a black spot on the steel, but not on the iron. See that the mouth of the scabbard is not split or swelled by driving in the mouth-piece. After sheathing the saber, draw it from the scabbard nearly to its full extent, and return it with considerable force three or four times in succession; then examine the riveting of the tang to the hilt. See *Small-arms*.

FABRICATION OF TUBES.—Two plans of conversion of our 10-inch smooth-bore cast-iron guns into 8-inch muzzle-loading rifles, by lining with coiled wrought-iron tubes, find place in our service; one by "muzzle," and the other by "breech" insertion. The parts in general of these converted rifles are: first, the old casing bored out to the exterior diameter of the inserted tube; second, the rifled coiled wrought-iron tube. The mode of manufacturing the iron for the tubes is fully explained in the article COILED TUBES. The A or main tube is composed of four sections or short tubes welded together, each section consisting of two bars, which are united end to end before coiling. The B tube and jacket for tubes, designed to be inserted from the muzzle and from the breech respectively, have now to be made. Their construction, which forms the principal feature of distinction between the two plans of conversion employed, will be subsequently described. The breech-cup is made from a solid forging stamped into shape under the steam-hammer. The collar for securing the tube at the muzzle is made of tube-iron, fagoted and hammered out to the proper size. It is then bent over a mandrel and the ends welded together. The tube and its accompanying parts have now to be transferred to the finishing-shop and prepared for insertion. The power is distributed from the engine by the shafting, which consists of rods of iron running the length of the workshop, and which, by means of attached pulleys, transmit the power used to the different machines. The motion is transferred by means of belts or bands, ordinarily of leather, passing from those above mentioned to similar pulleys. These belts may run direct to the machines themselves, but more usually pass over an intermediate pulley attached to the countershafting; this is placed below the main shafting, and carries pulleys of different sizes, and idle pulleys, by the former of which the rate of speed may be varied, by the latter the machine brought to rest without interfering with the motion of the main shafting. It is frequently necessary to reverse the motion of a machine, and this is effected by using a belt which is crossed between the pulleys over which it passes. While belts are generally employed to transfer rotation from one axle to another where these are at a considerable distance apart, when they are very near each other toothed wheels are used of different form and size, according to the relative positions of the axles and the work the machine is required to perform. When the axles are parallel, spur-wheels are used, in which the teeth project radially from the circumference. When the axles are not parallel, bevel-wheels are employed, in which the teeth are formed on the surface of a cone. Miter-wheels belong to the latter class, and are used when the axles are at right angles, and frequently for simply changing the direction of motion. To enable the various machines to perform the work required of them, the rotary motion of the shafting must be converted into rectilinear and other motion. Circular motion is changed into rectilinear by means of cams. Rectilinear motion is converted into circular by a crank, or by means of a pawl and ratchet-wheel, the pawl being on a jointed arm worked by a cam; the former gives continuous, the latter intermittent motion. The A tube and B tube or jacket are now bored, turned, and otherwise prepared for assembling; the tube turned down for the reinforcing tube and muzzle-collar; the breech-cup turned on the inside and a screw-thread cut on the outside, and the muzzle-collar bored out and a screw-thread cut on the exterior. The gun-casing is also bored to receive the tube, and a recess and screw-thread cut on the muzzle-collar. Much of this work, including that of preparing the sections for welding, is performed in the lathe shown in the drawing. This work requires much power, and, as a consequence, low speed. The power received from the main shafting is first reduced by the countershafting, and afterwards to a different degree by the different steps of the conical pulleys attached to the head-stock. The face-plate is fastened to a mandrel, which passes through the conical pulley and is independent of it. The motion of the conical pulley is transferred in a reduced form to the face-plate by the gearing. When it is desired to give the face-plate the same rate of motion as the conical pulley, the two can be bolted together, and the intermediate gearing thrown out of gear. The cutting-tool is attached at any inclination to a holder, which can be moved by hand on the slide-rest, longitudinally or transversely, by means of the handles shown in the drawing. These motions are made automatic by a connection, through gearing, with the feed-screw. An automatic longitudinal motion is given to the base of the slide-rest by means of the feeding-shaft and worm, while it is moved by hand in the same direction—when thrown out of gear with the feeding-shaft—by means of the pinion gearing into the rack. The leading-screw gives all the required longitudinal motion to the slide-rest in screw-cutting. A series of change-wheels is provided with each lathe, by a suitable combination of which any desired pitch can be given to the thread cut. The back-center can be adjusted by hand to any position, and in many machines an automatic longitudinal motion is also provided by means of gearing in rear, to enable it to carry a boring-rod.

In boring short tubes, such as the sections of the A tube, the cutter is generally passed through a slot in the boring-bar, which passes, in an ordinary lathe, from the head-stock to the back-center. The tube is then attached to a saddle which has a motion of translation, while the cutter has the motion of rotation received from the head-stock. Ordinarily, both in boring and turning, the cutter has the motion of translation, while the tube revolves. In boring or turning cast-iron, it is not usual to use a lubricant. In turning wrought-iron, a mixture of soap and water is allowed to drip upon the tool, which serves to diminish the friction on the tool and preserves its temper. In boring wrought-iron, no lubricant need be used for the rough-cut, but oil must be used during the finishing-cut. Previous to the first turning of any article, the axis must be found so as to center it truly in the lathe. This is simply done in a solid cylinder by finding centers at each end with a pair of compasses; but in the case of a tube a mandrel must be inserted in each end in order that the axis may be actually obtained. After the casing has been bored out to receive the tube, careful measurements are made with the star-gauge for every inch of length of bore. These measurements, plotted on paper, are the workman's guide in so finishing the tube that the play between it and the casing shall not exceed that prescribed. Before shrinking the reinforcing-tube upon the tube proper, both are subjected to the hydraulic test. The apparatus for applying this test consists of two iron cross-heads fitted to the ends of the tube, and which are enabled to sustain the pressure applied through the medium of the connecting rods. Leather washers are used to render the cross-heads water-proof. The water is forced in by a steam-pump through one of the cross-heads, and the degree of the pressure—which must reach 120 pounds to the square inch—is registered by the gauge. The reinforcing-tube is now shrunk on, and the united tubes returned to the bed and finished, and then inserted in the casing. The muzzle-collar is then screwed into place, and the steel securing-pin is inserted through the casing. It is usual to rifle the tube before it is inserted in the casing; but as it is not unfrequently done at this stage of the work, the description of it is here introduced. Only a single groove is cut at a time, and that, ordinarily, as the cutter is going down the bore. All the grooves in a gun are first cut out



Boring and Section Lathe.

roughly and then finished with another cutter. The distance between the grooves is regulated by a disk fixed to the breech of the gun, having its periphery equally divided by as many notches as there are to be grooves. The gun is fixed each time by a pawl, and, when a new groove has to be cut, is turned round to the next notch. Sometimes the periphery is simply subdivided into the required number of equal spaces, while a stationary pointer indicates the position to which the marks on the disk are to be successively brought. The gun is held horizontally in its bed in front of the machine, and remains stationary while the head carrying the cutter moves in and out the bore. Consequently it is necessary to make the bar, to which the head is attached, turn as it advances and returns. Many varieties of machines are used in this country for rifling guns. They differ from each other in the mechanism employed to give this motion of rotation to the cutter. In all of them, the gun-metal head, which carries the cutter, fits the bore accurately by means of burnishers. It is fastened to a stout, hollow iron bar, termed the "rifling-bar." This bar is fixed to a saddle which can be moved backwards and forwards, but is capable of a motion of rotation independent of it. During rifling the metal on the edges of the grooves occasionally becomes burred. The bore must therefore be smoothed, and this is accomplished by a process called "lapping." The operation consists in working backward and forward in the bore a wooden head covered with lead and smeared over with emery-powder and oil. The bore of the gun-casing is also subjected to the same operation before the insertion of the tube. Both the tube and collar now project beyond the muzzle of the casing. They are therefore cut off flush with it, and finished. The hole is tapped for the vent-bushing, which is then screwed into place, and its lower end finished off flush with the surface of the bore. See *Coiled Tubes*, *Converted Guns*, and *Ordnance*.

FACE.—A term of varied application. 1. In fortification, it is an appellation given to several parts of a fortress, as the *face of the bastion*, which is the two sides, reaching from the flanks to the salient angles. The *prolonged* or *extended face* is that part of the line of defense which is terminated by the curtain and the angle of the shoulder. Strictly taken, it is the line of defense *rayant*, diminished by the face of the bastion. 2. In tactics, *to face* is to turn on the heels, as a *right face;* also the word of command for the movement. See *Fortification*.

FACE-COVER.—Engineers since the times of Cormontaigne have mostly adopted his method of placing the top of the scarp-wall on a level with the crest of the glacis, or a little below this crest, to give the wall cover from the assailant's distant batteries. But this is evidently only a partial remedy, since the plunge of projectiles fired from a distance is very great in the descending branch of the trajectory, and with the rifled guns now used these projectiles fired from a distance may pass over the glacis-crest and strike the wall quite low down, thus effecting serious damage, particularly in the case of very wide and shallow ditches.

Various expedients have been proposed by engineers to remedy this defect. Choumara, an engineer of celebrity, has proposed to form what he terms an interior glacis within the ditch, the crest of which shall rise so high above the bottom of the ditch that it shall mask the scarp-wall from the plunge of the distant batteries, and shall force the assailant to establish his breaching-batteries on this interior glacis to enable him to fire low enough to effect a practicable breach in the wall.

Brialmont, a more recent writer, proposes a like plan for the same purposes; and in one of our own works, Fort Warren, Boston Harbor, a heavy earthen face-cover masks a portion of the scarp-wall from a position from which a breaching fire might have been brought against the part thus masked. See *Permanent Fortification*.

FACE OF A PIECE.—In gunnery, the terminating plane perpendicular to the axis of the bore.

FACE OF A PLACE.—In fortification, the front comprehended between the flanked angles of two neighboring bastions, composed of a curtain, two flanks, and two faces. Sometimes called the *tenaille of the place*. See *Fortification*.

FACE-PLATE.—A plate screwed on to the spindle of a lathe, and affording the means of attaching the work to be turned; or the place of attachment for a pin which comes against the *dog* or *driver* on the work and imparts rotation to the latter. See *Lathe*.

FACES OF A SQUARE.—The sides of a battalion or regiment when formed in square.

FACHON.—An Anglo-Norman term for a sword or falchion; but little used. See *Falchion*.

FACING.—1. Powder applied to the face of a mold which receives the metal. The object is to give a fine smooth surface to the casting. The facing consists of various materials, economy and the description of casting being taken into consideration. The following are commonly used: Meal-dust or waste flour, powdered chalk, ashes of wood or tan, charcoal-dust, loam-stone powder, and rotten-stone powder. An equivalent effect is produced by depositing a layer of soot upon a metallic pattern by smoking it in a fire of cork-shavings, or of resin burned in an iron ladle, or in the flame of a link or a lamp. 2. The front covering of a bank by means of a wall or other structure to enable it to be made steeper than the natural talus of the material.

FACING-IMPLEMENTS.—Implements used for facing or renewing the vent and the breech-pieces of an Armstrong or similar gun.

FACINGS.—1. The cuffs and collars of military coats, which are generally of a different color from that of the coats. 2. The movements of soldiers by turning on their heels to the right, left, right-about, left-about, etc.

FACTION.—1. In ancient history, one of the troops or bodies of combatants in the games of the circus, especially of the horse-races. 2. A term applied in an ill sense to any party in a State that offers uncompromising opposition to the measures of the Government, or that endeavors to excite public discontent upon unreasonable grounds. 3. The duty done by a private soldier when he patrols, goes the round, etc., but most especially when he does duty as a sentinel. The French usually say, *entrer en faction*, to come upon duty; *être en faction*, to be upon duty; *sortir de faction*, to come off duty.

FACTIONNAIRE.—A soldier who does every species of detail duty. The term was likewise applicable to the duty done by officers in the old French service.

FAG-END.—The end of any rope. The term is generally applied to the end of a rope when it has become untwisted. *To fag out* means to wear out the end of a rope or a piece of canvas.

FAGOTS.—1. In military history, men hired to muster by officers whose companies were not complete; by which means they cheated the public out of the men's pay, and deprived the country of its regular establishment. 2. Fascines of brushwood, used to revet the interior of batteries, embrasures, etc. See *Fascines*.

FAKING.—Faking is an operation which requires some care. Any person may learn to do it in a kind

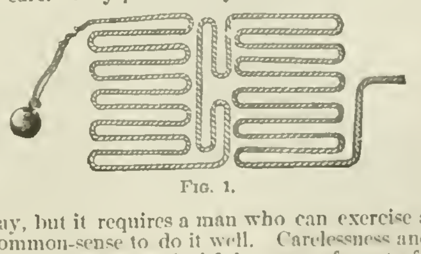


Fig. 1.

of way, but it requires a man who can exercise a little common-sense to do it well. Carelessness and ignorance are the most fruitful causes of want of suc cess in laying up the lines by this method. Practice alone can make a successful "faker." One man *may* fake a line, but having to attend to three operations at the same time, does none of them properly. Two men may put up a line, but, as before, there being more operations than men, they often fail. Three men *can* fake a line well. This work requires a certain degree of care and common-sense. The necessity for thorough instruction and frequent practice is nowhere so urgently called for as in the fitting of men to handle efficiently the appliances for saving human life.

The method shown in Fig. 1 has, after various trials, been found the most practical for laying the rope and placing it into compartments. A particular attention to this mode will never fail with a good

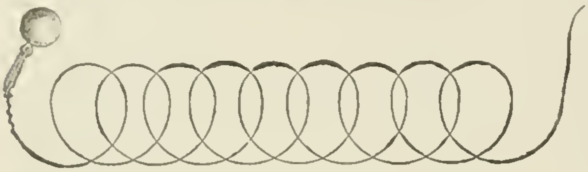


Fig. 2.

rope when the impediments are removed that might otherwise obstruct its rapid flight. Its advantages are that it will allow the eye rapidly (yet correctly, *just before firing*, which is absolutely necessary) to pass over the different compartments, and at once discover if any fake has been displaced by the storm, or by any other casualty or accident come in contact with another part, which would destroy its application by the rope breaking.

It may likewise be coiled in the manner used in the whale-fishery, *whale-lair*, as shown in Fig. 2, and in the method called *chain-faking*, shown in Fig. 3. It is, however, necessary to add that great attention is required in laying it agreeably to the two latter methods, arising not only from the arm being liable to get under certain parts of the rope, and thereby displace it, but from the great anxiety of mind natural on these occasions, where the lives of fellow-creatures are literally dependent on the correctness with which the rope is laid. It is therefore extremely difficult, in a moment of agitation, to determine whether any overlay has taken place, an error that would infallibly destroy every endeavor, and occasion even the fate of those whose lives we might be exerting our-

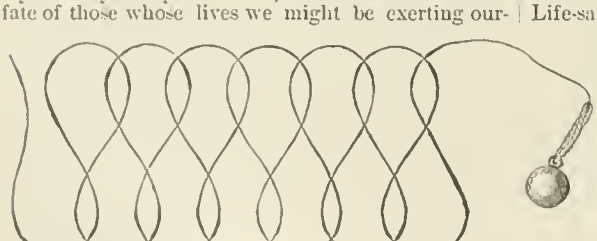


Fig. 3.

selves to preserve. Could persons in the performance of this service be always collected, the two latter methods would have a decided advantage over the first mode of faking, they being laid in a much less space of time. As all these methods of laying the rope occupy time to place it with the care necessary, and as it has repeatedly happened that vessels very soon after grounding have gone to pieces, and all hands perished, it was necessary to produce a method of arranging the rope so that it could be immediately projected as soon as it arrived at the spot; and none proved so effectual as when brought ready in a basket. In this case, the rope should be most carefully laid in alternate tiers or fakes, no part of it overlaying, and it should be well secured down, that in traveling it be not displaced; but above all, no mistake must happen in *placing the basket properly*. For example, that the end of the basket from which the shot hangs in the above figure should be previously marked, and must be placed toward the sea or wreck that the rope be delivered freely and without any chance of entanglement. It will be scarcely necessary to add there will be several tiers of the rope when laid. The utmost care and attention are required in laying the rope in tiers with strict regularity to prevent entanglement. See *Life-saving Rockets*.

FAKING-BOXES.—These boxes are designed for placing the shot-lines in position for firing. The lines are stowed away in the boxes in a peculiar manner, called "faking." The method is one adopted by the English for the stowage of their rocket-lines. In the pattern used in the United States, the sides and ends are dovetailed together at the corners. The top is nailed to the ends and sides with 1¼-inch and sixpenny finishing-nails. The cleats carrying the rope-handles are fastened to the box, one at each end, by four small screws. The "false bottom" has a row of holes, 1.2 inch (3.05 centimeters) in diameter, around the perimeter Along the sides and ends the centers of these holes are situated 1.3 inch (3.3 centimeters) from the edges. The distance between the centers of any two consecutive holes is 2 inches (5.08 centimeters). The sides and ends of the frame for the faking-pins are put together with mortises and tenons. Along the sides, the centers of the screw-holes for the faking-pins are placed 2.5 inches (6.35 centimeters) from the outer edges; the centers of these holes are 3 inches (7.62 centimeters) from the outer edges along the ends of the frame. The distance between the centers of any two consecutive screw-holes in 2 inches (5.08 centimeters). These holes are bored and tapped to form a coarse-threaded female screw. There are seventeen holes on each side and seven at each end of both the bottom and the frame, making forty-eight holes in each. The faking-pins are turned in a lathe from pieces of hickory of the proper length. The body is a frustum of a cone. The upper end is slightly rounded off. A coarse cylindrical screw is cut upon the lower end. A metallic hasp which passes over a button attached to the end of the box is fastened to each end of the frame, and serves to hold the frame and box together in transportation and handling.

The method of fastening in use in the United States Life-saving Service prior to 1879 was simply two staples and a hook. In transportation the hooks were liable to drop out of the engaging-staple on the box and permit the frame carrying the faking-pins and shot-line to fall to the ground and the line to become entangled. While experimenting with life-saving apparatus during the years 1877–'78, Lieutenant D. A. Lyle, Ordnance Department, U. S. A., contrived a metallic hasp and turn-button to replace the old hook and staple. In his report of 1878 he says: "Hasps and turn-buttons were tried on the experimental boxes; these, though safe, sometimes gave trouble in getting ready for the firing when in great haste, and the button being placed on the box, it was thought to give an opportunity for the line when vibrating or whipping to catch and be cut off." In view of these disadvantages, Lieutenant Lyle devised a fastening of three staples, a hasp, ring, safety-chain, and lever snap-hook. The lever snap-hooks are made of malleable iron; the two large staples and hasp of wrought-iron; the small staple, ring, and safety-chain of brass. The whole are tinned, to protect them from rust. The only thing attached to the box is one of the large staples; consequently there is nothing on the faking-box that can interfere with or injure the line so far as the fastening is concerned. The other parts are all attached to the "frame," and are removed with it when preparing for firing.

The operation of the lever-snap is very simple. The mere act of hooking the snap in the staple compresses the spring, raises the bent end of the lever, allows the staple to pass within the hook when the elastic force of the spring closes the snap, and locks it. To remove the hook from the staple, seize the looped end with the thumb and index-finger, and press them together. This action will depress the end of the lever on the opposite side of the fulcrum from the hook and unlock the snap so that it can be withdrawn from the staple. These lock-snaps were intended for the use of harness-makers, and hence the lengthened slot at the end opposite the hook—which was made for the attachment of a strap or rein of a given width. This length of slot is unnecessary as regards the convenience of fastening the safety-chain and snap-hook together, but serves a most useful purpose in the Life-saving Service. The excess of length of slot necessitates a corresponding amplitude of the rear end of the hook, and allows a much wider cavity for the play of the rear end of the bent lever. It also admits of this end of the lever being made spatula-shaped. The size of the cavity and end of lever are such that the snap may be unlocked with ease by the surfman, no matter how large his thumb may be or how thick the gloves or mittens that he is wearing. This is a point of great importance, as the surfmen can manipulate this portion of the apparatus in the coldest weather without removing their hand-coverings.

The German faking-boxes are very similar to those in use in the United States. They differ from the American box in being longer, a little less in width, and far more complicated in construction. The top of the box has three equidistant transverse cleats on the upper side to strengthen it. A lip at each end overhangs the end of the box. Iron straps attached to the lid and run inside of the box form the hinges. These hinges are held in position and swing upon iron pins 5.875 inches in length, having an eye at one end and a slot at the other. A leather thong is made fast in the eye-hole, and is long enough to pass through the slot in the other end of the pin. This pin is thrust through the cylindrical heads of the hinge-straps on the box and lid, and the thong is passed through the slot to secure the pin in position. This arrangement admits of the top or lid being removed entirely when desired. Two slotted straps or hasps attached to the front side of the lid engage the staples on the front of the box. The body of the box is rectangular in shape, open at the top and bottom, and of sufficient depth to contain the faking-pins and line.

It has been found that the term of service of a wooden faking-box is very short. The vibrations of the line, when the full charge of powder is used, are so violent that the ends of the box are often split, and sometimes the sides and top. It was for the purpose of preventing this splitting that angle-pieces of cast-brass were placed upon the four corners. Though this method of construction has remedied the defect to a certain extent, it has not fully obviated it. To secure the necessary lightness of the box, it was requisite that it be made of light wood, and that the material be very thin; consequently the box is quite fragile. If a material can be obtained that will possess a greater degree of durability than one made of wood, and weigh no more than the latter, that material should be adopted, provided the cost of manufacture be reasonable. See *Faking* and *Life-saving Rockets*.

FAKIR.—A word derived from the Arabic *fakhar* (poor), and designating a member of an order of mendicants or penitents, chiefly in India and the neighboring countries. In Persia and Turkey the word is also used for Moslem priests and dervishes. The origin of fakirism, an institution which reaches back to the most remote antiquity, is lost in mythical darkness. The common account of the son of a mighty Rajah, who, expelled from his home and country by the cruelty of his father, made a vow, half in revenge and half in contrition, henceforth to roam a beggar through the world, and to win proselytes to a life of poverty and self-mortification, as the one most befitting in man and most pleasing to the Deity, can hardly be called historical. The same yearning for rest, for peace and pious contemplation, for escape from the noise and turbulence of the world, which has everywhere and always led still and pensive minds into seclusion and solitude, must naturally have been more powerful here, in a land which yielded almost of itself, and in abundance, all that was necessary for the sustenance of man—in a climate of flower and sunshine, where a hermit's calm retreat might well rise before the wearied eye in all the soft sunset hues which surround the abode of the recluse in the Ramayana or in the Sakoontala. But constant seclusion and ceaseless meditation here, as elsewhere, produced in all but exceptional minds their sad results. Piety is no longer enough; sanctity is the goal. Thus, abstinence becomes mortification and a self-torture; mental repose, mystic self-absorption or frenzied exaltation. This leaning of the Hindus to a life of asceticism was fostered by their primeval religion, which enjoins various exercises of penance and mortification upon the three higher castes in general, but upon the Brahmins in particular. These, having passed through different stages of regeneration, end by becoming Sanyassis ("who have left everything") and are dead to the law. The world and its usages have no more any claim upon them; even religious ceremonies are no longer necessary to the "united with God." They go naked or in filthy rags, receive the meanest food only, and that without either a demand or thanks. Their ethical code consists in the observance of truth, chastity, internal purity, constant repentance, and contemplation of Deity. After these models fakirism seems chiefly to have been framed, and its adherents were not only pious men, but occasionally saints, workers of miracles, and healers of all ills, especially epilepsy and sterility. The halo which from the first surrounded fakirism, and the ready worship offered by the people, attracted to its ranks, at a very early date, many whose motives were anything but pure, and who, under a garb of humility and mendicity, collected fabulous treasures. Strabo already distinguishes these vagabonds from the more honest members of their class, and if we may trust the travelers of our own day, the more respectable element has now altogether disappeared. Their number is variously stated. In the time of Tavernier's visit there were more than 1,200,000 Hindu and 800,000 Mohammedan Fakirs in the East Indies, and their present number is said to exceed 3,000,000. Papi describes the Mohammedans as guilty of the greater follies. At times, especially in their return from distant pilgrimages, they are even dangerous, as the killing of an unbeliever is supposed to be an infallible introduction to the glories of paradise. They live either separately as hermits or solitary mendicants, or unite in large gangs, carrying arms and a banner, beating drums, and sounding horns as they approach a town or village. Their appearance is disgusting in the extreme; they go naked, besmeared with the dung of the holy animal, the cow. Some bedeck themselves with the skins of serpents, some with human bones; others array themselves in the garb of women. Their fearful shrieks, and the hideous rollings of their eyes, add to the disgust of their appearance. Imitating madmen, they generally end by becoming madmen. The height to which self-torture is frequently carried by these wretched fanatics, and of which we meet with signs even so far back as the Ramayana, where a penitent is described as perpetually sitting with upraised arms between four fires, the sun forming the fifth, is so appalling that human nature shrinks from the mere description. Some pass their whole lives in iron cages, laden with heavy chains; some clinch their fists till their nails grow through the hand; others hold aloft both their arms till they become like withered branches; while others, again, tie their hands and feet together, and roll head over heels for thousands of miles. Not the least sad feature in all this is that these religious antics are not confined to men, but that youths, and even children of tender age, are initiated therein.

FALARIQUE.—Combustible darts or arrows of various thicknesses, generally about 3 feet long; close behind the head was lodged the combustible matter, by which shipping, etc., was set on fire. The falarique was projected from a bow or catapult.

FALCAIR.—A soldier who was armed with a *falcarius*, or short crooked sword.

FALCHION.—A peculiarly shaped broad-bladed sword, added to the offensive weapons used in the reign of Edward I., 1272–1307.

FALCON-BEAKED.—A term applied to battle-axes and the like when large and curved.

FALCONET.—A name used in the fifteenth and sixteenth centuries for the smallest class of cannon. The ball weighed from 1 lb. to 3 lbs., and the gun from 5 cwt. to 15 cwt.

FALL.—1. In artillery material, the name given to any rope which is passed through blocks, so as to form part of a tackle. The rope attached to a gin, which passes over a double and triple block, the end of it passing round the windlass, is termed the *fall*. The fall for this purpose is generally made of strong rope, depending on the weight to be lifted.—2. The surrender or capture of a place after it has been besieged.—3. The descent of a body by the attraction of the earth.

FALL FOUL.—An expression used in the military sense of making an attack or assaulting.

FALL IN.—The word of command for soldiers to form in ranks, as in parade, line, division, etc.

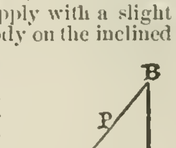
FALLING BODIES.—Owing to gravity, all terrestrial bodies, if unsupported, *fall*, or move towards the earth's center. When a falling body is absolutely without support, it is said to fall freely, as distinguished from one descending an inclined plane or curved surface. We shall here consider the two cases of free descent and of descent on inclined planes.

1. *Bodies falling freely.*—The first fact of observation regarding falling bodies is that they fall with a variable velocity; from this we infer that they are acted upon by some force. Again, on observing how the velocity varies, we find that its increments in equal times are equal; from this we conclude that gravity is a uniform force, which it is, at least sensibly, for small distances above the earth's surface. We have next to find a measure for this force. By experiment it is found that a body in 1 second falls through 16.1 feet, and that at the end of 1 second it moves with such a velocity, that if it continued to move uniformly after the 1 second expired, it would pass over 32.2 feet in the next second. Hence 32.2 feet is the measure of the velocity which has been generated in 1 second, and is therefore the measure of the accelerating force of gravity; for the measure of accelerating force is the velocity which it will produce in a body in a second of time. The quantity 32.2 feet is usually denoted by the letter g; and it is proper to mention here that this quantity measures the accelerating force of the earth's attraction on all bodies. Experiment shows that under the exhausted receiver of an air-pump all bodies fall with equal rapidity, and that the difference of velocities of falling bodies in air is due entirely to the action of air upon them. As the accelerating force is uniform, it follows that the velocity generated in any time, t, will be given by the formula $v = gt$. Since the force is uniform, it must generate an equal velocity every second. In t seconds, therefore, it must generate a velocity gt, since it produces g in 1 second. In 2 seconds, a falling body will be moving with a velocity of 64.4 feet—i.e., were the velocity to become constant for the third second, it would in that second move through 64.4 feet. We are now in a position to inquire more particularly how bodies fall, and to answer such questions as—First: What time will a body falling freely take to fall through a given space? Second: What velocity will it gain in falling through a given space? Third: How high will a body ascend when projected straight up with a given velocity? etc. Let A be the point from which a body falls, and B its position at the end of the time t; and let AB = S. Then we know that at B the body has the velocity gt. Suppose, now, the body to be projected upwards from B towards A with this velocity gt—gravity acting against it, and tending to retard its motion. We know that at the end of a time t it will be again at A, having exactly retraced its course, and lost all the velocity with which it started from B, because gravity will just take the same time to destroy the velocity gt which it took to produce it. From this consideration we may obtain an expression for the space AB or S in terms of the time t. In the time t, the body rising from B with a velocity $= gt$ would ascend, if not retarded, a height $(gt) \cdot t$, or gt^2. But in the time t, gravity, we know, carried it through S; it will therefore, in the same time, by retarding it, prevent it going to the height gt^2 by a space = S. The space through which it actually ascends is then represented by the difference $gt^2 - S$; but this space we know to be AB or S. Therefore $S = gt^2 - S$; or $2S = gt^2$, or $S = \frac{1}{2}gt^2$. We may give this equation another form. For v being the velocity acquired in the time t, $v = gt$, $\therefore t = \frac{v}{g}$. Then $S = \frac{1}{2}g \cdot \frac{v^2}{g^2} = \frac{v^2}{2g}$. Hence $v^2 = 2gS$. From these formulæ we see that when a body falls from rest under the action of gravity, its velocity at any time varies as the time, and the square of its velocity as the space described. If the body, instead of starting from rest, has an initial velocity V; and if v, as before, be the velocity at the time t, then evidently v is = the original velocity + that which is generated by gravity, or $v = V + gt$; and the space will be that which would have been described by the body moving uniformly with a velocity V + that which it would describe under gravity alone, or $S = Vt + \frac{gt^2}{2}$. With regard to the last two formulæ, it is easy to see that they may be made to suit the case of a body projected upwards with a velocity V, by a change of signs; thus $v = V - gt$, and $S = Vt - \frac{gt^2}{2}$; gravity here acting to destroy velocity and diminish the height attained. From the general formulæ in the case of an initial velocity, whether the body be projected upwards or downwards, we may express v in terms of S, as we did in the case of motion from rest. For

$$v^2 = (V \pm gt)^2 = V^2 \pm 2g\left(Vt + \frac{gt^2}{2}\right) = V^2 \pm 2gS.$$

These are all the formulæ applicable to the case of falling bodies, and by their means all problems in this branch of dynamics may be solved. It also appears that the formulæ above investigated apply to all cases of rectilinear motion of bodies considered as particles under the action of any uniform force. In all such cases, if f measure the accelerating force $S = \frac{1}{2}ft^2$, $v^2 = 2fS$, for the case of motion from rest; and $S = Vt \pm \frac{1}{2}ft^2$, and $v^2 = V^2 \pm 2fS$, for the case of an initial velocity.

2. *Bodies descending inclined planes.*—In this case the formulæ already investigated apply with a slight change. In the figure, if P be a body on the inclined plane AB, descending under gravity, we observe that only that resolved part of gravity parallel to AB is effective to make it descend, the other part at right angles to AB merely producing pressure on the plane. The angle of inclination of the plane being α, we know that the resolved part of gravity parallel to the plane is $g \sin \alpha$. The body, then, may be conceived to be descending under a uniform accelerating force $g \sin \alpha$. We obtain the formulæ, ac-



cordingly, for descent on inclined planes by substituting $g \sin a$ for f in the general formulæ given above. We notice, however, that in descent on inclined planes the velocity acquired is, as in the case of bodies falling freely, due solely to the vertical height through which the body falls. By our formula, $v^2 = 2g \sin a$. S, where S = AB, if the body falls from B. This may be written $v^2 = 2g$. S . $\sin a$, or $= 2g$. AB . $\sin a$, or $= 2g$. BC, since AB . $\sin a$ = BC. But this is the same as the velocity acquired by a body in falling freely through BC. In fact, it holds generally true that the velocity acquired by a body falling down the surface of any smooth curve is that due to the vertical height through which it has fallen; which might be proved in various ways, but is sufficiently clear from this, that any curve may be considered as a succession of inclined planes, indefinitely short in length and great in number; for the proposition being true, as above proved, for each of them, will be true for all, and therefore for the curve. See *Atwood's Machine*, *Parallelogram of Forces*, and *Projectiles*.

FALLING BRANCH.—That part of the trajectory of a projectile in which it approaches the earth. See *Trajectory*.

FALL OUT.—To quit the rank or file in which one is first posted. Untidy soldiers on parade are frequently ordered to *fall out*, and remain in the rear of their companies. The phrase is applicable in a great variety of instances.

FALOIS SYSTEM OF FORTIFICATION.—The front of this system consists of two enceintes of equal command, so that the inner one is well covered. The bastions contain cavaliers which may readily be transformed into retrenchments. The second enceinte consists of counterguards and ravelins connected by batardeaux. A low battery forms the reduit of ravelin. The ravelin, its reduit, and the counterguard are casemated for artillery. The covered-way is replaced by a system of crémaillères, which possess the great defect of furnishing the besieger with a parallel ready made.

FALOTS.—Small lanterns fixed upon the end of a stick or pole. Small lamps likewise used, attached in the same manner, for the purpose of carrying them readily about to light a camp, or besieged towns, as occasion may require.

FALSE ALARMS.—Stratagems of war frequently made use of to harass an enemy by keeping him perpetually under arms. A vigilant officer will occasionally make a false alarm to learn if his guard is on the alert. A fearful or negligent sentinel will create alarm by false reports.

FALSE ATTACK.—An approach which is made as a feint for the purpose of diverting an enemy from the real object of attack. False attacks should be carried out on several points of the works to be attacked, and at the same time as the real one is going on. The strength of the force detailed for this duty should be imposing. See *Feint*.

FALSE FIRES.—Lights or fires employed for the purpose of deceiving an enemy. When an army is about to retire from a position, during the night false fires are lighted in different parts of the encampment to impose upon the enemy's vigilance.

FALSE FRAMES.—When the soil is very bad, the miners make use of these frames. They are of the usual height, but narrower, and exactly of a width from outside to outside, equal to the width in the clear of the ordinary frames.

FALSE IMPRISONMENT.—Every confinement of the person is an imprisonment, whether it be in a common prison or a private house, or in the stocks, or even by forcibly detaining one in the public streets. A man is liable for detaining the person of another, not only without cause, but without legal cause. Thus, where a man gives another in charge for committing an offense, the former is liable to an action for false imprisonment if he fails to substantiate his cause. Police-officers, also, are liable for apprehending a man without a competent warrant, or without reasonable suspicion. But where a felony has been committed, an Officer is entitled to arrest on suspicion. Not only Constables but private persons may arrest a man who commits a felony in their presence. A person who has falsely imprisoned another is liable to a criminal prosecution, and also to a civil action. In the former case he may be punished by fine and imprisonment; in the latter, he must pay such damages as are awarded. Any one detained without sufficient cause is entitled to apply for a writ of *habeas corpus* to procure his liberation. In Scotland this species of offense is called Wrongous Imprisonment.

FALSE LIGHTS.—In debarkations under cover of the night, lights may be used as signals of deception, when it is found expedient to attract the attention of the invaded country towards one part of the coast or territory, whilst a real attack is meditated against another. See *False Fires*.

FALSE MUSTER.—An incorrect statement of the number of effective soldiers and horses. Any officer who knowingly makes a false muster of man or horse, or who signs, or directs, or allows the signing of any muster-roll, knowing the same to contain a false muster, shall, upon proof thereof by two witnesses, before a Court-Martial, be dismissed from the service, and shall thereby be disabled to hold any office or employment in the service of the United States.

FALSE RETURN.—A willful report of the actual state of a brigade, regiment, troop, or company, by which the Commander-in-Chief of the War Department is deceived as to the effective force of such regiment or company. Every officer who knowingly makes a false return to the Department of War, or to any of his Superior Officers, authorized to call for such returns, of the state of the regiment, troop, or company, or garrison under his command; or of the arms, ammunition, clothing, or other stores thereunto belonging, shall, on conviction thereof before a Court-Martial, be cashiered. See *False Muster*.

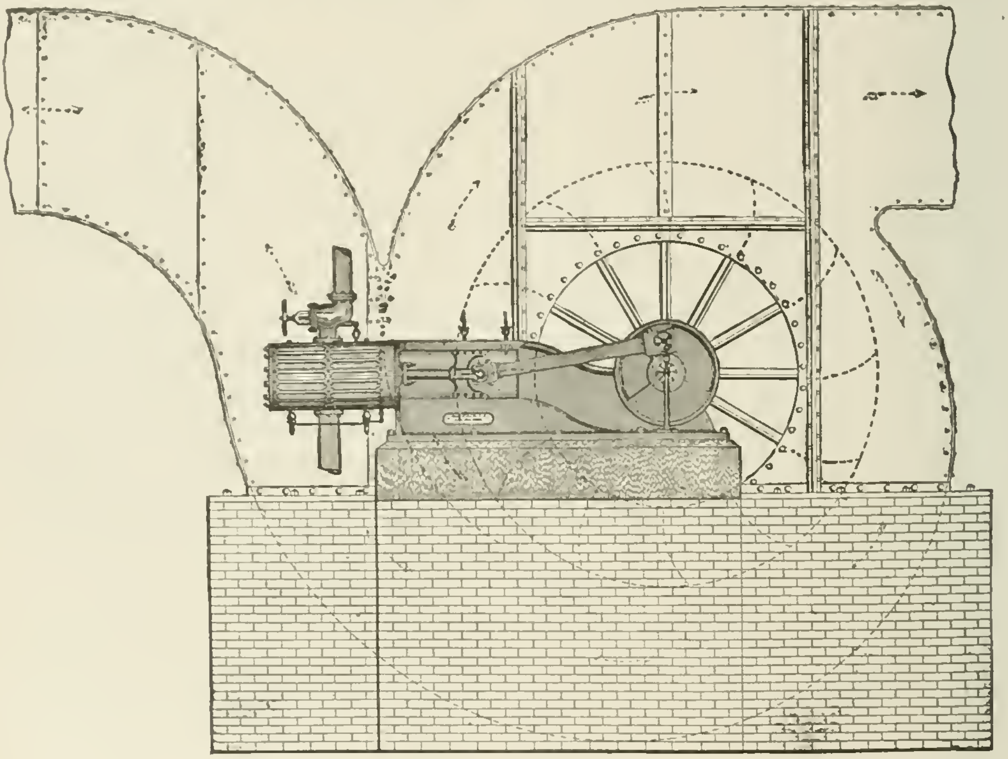
FANARIOTS.—The general name given to the Greeks inhabiting the Fanar or Fanal in Constantinople, a quarter of the city which takes its name from the beacon (*phanarion*) situated in it. They first appear in history after the taking of Constantinople by the Turks, and appear to have been originally descendants of such noble Byzantine families as escaped the fury of the barbarians. Afterwards, however, the class was recruited by emigrants from different parts of the old Byzantine Empire. Subtle, insinuating, intriguing, they soon took advantage of the ignorance of the Turkish Governors, and made themselves politically indispensable to their Rulers. They filled the offices of dragomans, secretaries, bankers, etc. One of them, named Panayotaki, at a later period, was appointed Dragoman to the Divan, and his successors obtained still greater honors. Through their influence the lucrative office of Dragoman of the Fleet was called into existence, which gave them almost unlimited power in the Islands of the Archipelago. Besides, from them were chosen, until the outbreak of the Revolution in 1822, the Hospodars of Wallachia and Moldavia, while, in addition, the disposal of most of the civil and military posts under the Turkish Government was in their hands. In spite of their power, however, the Fanariots never exhibited much patriotism; they were animated by the petty motives of a caste, and when the War of Liberation broke out among their countrymen, they took no part in it. In the present altered state of affairs in Turkey, they have no political influence.

FANFARE.—The French name of a short and lively military air or call, executed on brass instruments. It was brought by the Arabs into Spain, whence it passed into Mexico and the New World. *Fanfaron*, derived from fanfare, is the name given to a swaggering bully or cowardly boaster, probably because of the empty noise he makes when "blowing his own trumpet," or threatening timid people, and the term applied to his idle braggadocio and vaporing vaunts is *fanfaronnade*.

FANION.—A small flag which was sometimes carried at the head of the baggage of a brigade. It was made of serge, and resembled in color the uniform-livery of the Brigadier, or of the Commandant of any particular Corps.

FANNER.—A machine of great value for producing currents of air and creating blasts to melt pig-iron in foundries. It is much used in the ventilation of hospitals, armories, ships, and mines. For the last it is now considered preferable to the plan of furnace-ventilation, especially where there are fiery seams of coal. In its construction the fanner is like a wheel, having the arms tipped with vanes, instead of being joined by a rim. It is placed inside a chest—usually in an eccentric position—with openings on each side round the spindle for the admission of air. The motion is given by steam or other power; and as it revolves, the centrifugal action sucks in air at the center, largely augments the working pressure. In Platt and Schiele's silent fanner the air enters by a central entrance at one side only, and is expelled from the case at the opposite side. The vanes have a peculiar shape, and describe what the inventor (Schiele) calls an anti-friction curve. It is said to be very efficient, and so also is another form of noiseless fanner manufactured by Mr. George Lloyd, London.

The drawing shows a form of Sturtevant's exhausting fanner especially adapted for use in any place where the blower can be placed in the basement, and the air be used for the ventilation of rooms above. In such cases it can be used as an exhauster by closing up the inlet on engine side and connecting a pipe or duct to the opposite side, bringing the air from any distant point where it can be had fresh and pure. This manner of discharge is also most convenient and desirable when used for exhausting foul air, gases, smoke, etc.,



Sturtevant Exhausting Fanner.

draws it towards the tips of the vanes, and these impel it forward through the exit-pipe. Engineers differ as to the proportions which should be adopted for the fanner, and as to the extent of spiral which the fan-case should have. For foundries and smithies, where the pressure of the blast required is from four to five ounces per square inch, the following have been found to suit very well in practice: the width of the vanes, as well as their length, made one fourth of the diameter of the fanner; the inlet openings in the sides of the fan-chest one half, and the degree of eccentricity one tenth, of this diameter. There is a segmental slide by which the opening into the delivery-pipe may be increased or diminished. For such purposes fanners vary from three to six feet in diameter, and they are entirely constructed of iron. Double fanners have been introduced by Mr. Chaplin in England, by M. Perrigault in France, and by Mr. Sturtevant in America. In these, two simple fanners are so disposed on one spindle that the blast produced by one passes in its compressed state through a tube to the other, which from mines, tunnels, or other underground apartments, and it is desired to discharge it upward, out of the way of workmen, or above the tops of buildings. One of the happiest applications of the fanner has been to draw off and render harmless the shavings from planing-machines and the fine steel-dust in the operation of needle-grinding. It should be remembered that small, long branch-pipes with large openings for air around the revolving cutters, or between them and the hoods, cannot be made to work unless the exhauster is driven at a very high speed. Large pipes and close-fitting hoods around the cutters, fitting so closely that there will be no unnecessary opening for the air, will enable the exhauster to do its work with less number of revolutions. The velocity of the air entering the hood around the cutters should be about the same as the velocity with which the outside of the blast wheel travels, say one hundred to one hundred and fifty feet per second, according to the kind and dryness of the material being planed. The full power of the exhauster can only be felt at the planing-machine by means of large pipes and close-fitting hoods. The hoods should fit down as closely as is possible around the point where the shavings are to be made. See *Blower*, *Iron*, and *Steam-fan*.

FANTASSIN.—A foot-soldier. This term is derived from the Italian *fante*, a boy, the light troops in the fourteenth and fifteenth centuries being formed of boys who followed the armies and were formed into corps with light arms; hence the origin of the word.

FARCY.—A contagious disease among horses, depending upon the same causes as glanders, which it usually precedes and accompanies. The absorbent glands and vessels, usually of one or both hind-limbs, are inflamed, tender, swollen, hard, and knotted. The vitiated lymph thus poured out softens, and ulcers or farcy-buds appear. Unlike the ulcers of glanders they are curable, but require time and care. They must be scarified with the hot iron, which, to prevent their spreading, may also be gently run over the adjacent sound skin. Good feeding and comfortable lodgings are essential, and if they do not interfere with the appetite, give tonics, such as a dram each of sulphate of copper and iodine, repeated twice a day.

FARRIER.—A person who shoes horses and treats their diseases. The better class of Farriers often were, and indeed still are, men of great shrewdness and observation, sometimes possessing considerable experience, and with skillful, useful hands. Their management of sick horses is occasionally sensible, but generally altogether empirical. They have usually but crude ideas of the structure, functions, or diseases of animals, and pin their faith mainly on a few carefully-cherished recipes. To their calling as horse-doctors and shoeing-smiths they usually unite those of cow-leech and cutter of colts and pigs; and although still met with in many of the rural districts of England and Ireland, their practice is passing into the hands of regularly educated Veterinarians. In the United States army one Farrier is allowed to each troop of cavalry.

FARRIER-MAJOR.—A person formerly employed by the Colonel of a Dragoon Regiment to superintend the Farriers of troops. He has since been superseded by a Veterinary Surgeon. In the English army Farriers-Major and Farriers are Non-commissioned Officers in the Cavalry, Artillery, Engineers, and Military Train, whose duty it is to shoe the horses of the corps, and, generally, to assist the Veterinary Surgeon in exercising a proper care over the regimental animals. They receive the same pay as other Sergeants (with whom they rank); and, in addition, certain allowances proportionate to the number of animals in charge. The sum necessary to defray this allowance for a year is about £10,000.

FARROW COMBINATION-TENT.—This novel combination shelter, storm, and common tent, designed for active field-service, consists of a peculiarly shaped sheet of light canvas or other suitable material, having a strong cord and flaps (several inches wide) about its edges and furnished with *hooks* and *rings* or *tapes* at suitable intervals. The shape of the tent is described as follows: A B D C, in Fig. 1, is a rectangle; B F = $\frac{1}{2}$ F D; A E = $\frac{1}{2}$ E C; B F D and A E C are right angles. For *regular troops* C D = 6 feet, and for the *officer's tent* C D = 7 feet. The shape of the canvas is such as to permit its being secured about the kit so as to thoroughly protect it—the triangular end-flaps being folded over before rolling; also, when folded over from both sides along lines parallel to A C and B D, and at distances from them a little less than one fourth of C D, as in Fig. 2, to form an excellent bed-covering for a single sleeper. When spread upon the ground, the blankets are placed upon the central portion of the rectangle A B D C. In this manner a double layer of canvas covers all of the sleeper (his feet resting along the line A B) except his head, which appears at the triangular opening D H C. When used as a shelter-tent, the edges E C, C D, and D F rest upon the ground. When pitched in this manner the tent covers a maximum *available* space for a minimum canvas, with the following advantages: 1st. Quickly, easily, and securely pitched. 2d. The tent is composed of but one piece of canvas—the allowance of one man. 3d. Three of its faces are covered, two of which may be raised for the purposes of ventilation. 4th. By attaching a blanket, extra piece of canvas, or a second tent along the upper edge, the fourth face may be closed; or, by varying its inclination, more or less shade may be secured.

Two of these tents may be so combined as to form a tent having a large base and a small altitude, that will withstand a *wind storm* (a component less than one half of the force of the wind tending to overturn it). In consequence of the gradually sloping walls, there is much

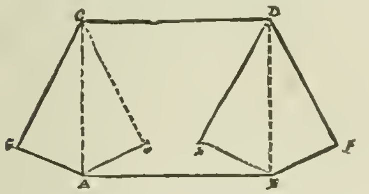


Fig. 1.—Form of Section-covering for Bed or Clothing.

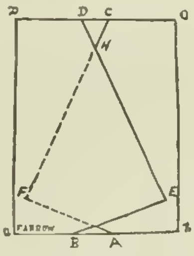


Fig. 2.—Bed-covering for Single Sleeper.

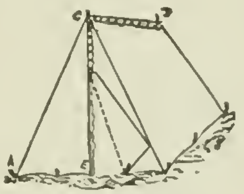


Fig. 3.—Used as a Common or "A" Tent.

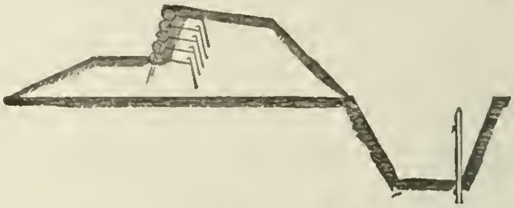
available space for the purposes of shelter and sleeping. By subjecting the canvas to a water-proofing process, it will shed the water during a *rain-storm* when pitched in this manner, and will not become heavy by wetting. If concealment be desirable, this form of tent is particularly valuable. Fig. 3 shows how two *shelters* may be combined so as to form the common or "A" tent. Here the canvas is reversed. The edge C D is at the ridge, and the edges E A, A B, and B F rest upon the ground. The poles used for the shelters are joined *two and two*, and form the long poles required for the common tent. This form of tent is particularly desirable during rain-storms, and is well suited for officers and others, living two in a tent, who are liable to become separated at any time. It moreover furnishes a covering for the kit of each, and the individual will at all times have his proper allowance of canvas with his own bedding, or in case of forced marches, etc., he may carry it on his person or behind the saddle. The poles are made of *strong and light wood*, with plain ferrule-joints and projecting screws, which serve to strengthen the joints and hold the corners of the canvas in place, being run through a worked hole or ring arranged for the purpose. The shelter-tent may be neatly pitched, without poles, whenever it is possible to suspend the ridge-rope (formed by uniting the guy-ropes) between trees or their branches, piles of stores, saddles, aparejos, rocks, etc.; or it may be pitched against a fence, fallen tree, etc. When without poles or any facilities on the open prairie, either the carbine or ramrod will make a good substitute.

The following extract from the proceedings of a Board of Officers convened at West Point, N. Y., to examine and report upon the merits of this tent will serve to point out its capabilities:—Dimensions of Officer's Tent pitched: First, as a shelter-tent. Base 7 feet square, 3½ feet high. Second, as a storm-tent, combining two shelter-tents, omitting the poles of one. Base 7 feet by 14 feet; 3½ feet high. Third, as a common or "A" tent. Base 7 feet square; 7 feet 2 inches high. Weight, including poles, 3 pounds 2 ounces. The following are some of the advantages of the tent: 1. Capable of subdivision. 2. Maximum *available* space for minimum canvas. 3. Same poles for each form of tent. 4. The tent is expeditiously pitched. 5. As a shelter-tent it is far more secure and roomy than the one now used. 6. Three faces of the tent are covered, and the fourth may be covered by a blanket or odd piece of canvas. 7. No ridge-pole is required. 8. The only ropes required may be used to tie up the bundle. 9. It is a superior wrapper for the bundle. 10. When not pitched it serves, on account of its peculiar form, as an excellent bed-covering. 11. It is the only practicable storm-tent, and to this point the Board particularly invite attention. 12. It forms a roomy and convenient "A" or common tent, and as it can be opened at both ends, it can be rendered more comfortable in warm weather than the old tent. 13. Thirty-four tents (officers') or forty tents (men's), with poles in suitably-constructed bags, form a handy pack for a mule. The common tent is here referred to. 14. If transportation is abandoned, the tent is readily borne on the person. 15. It is readily adapted to the wind- or rain-storm. 16. The shelter-tents are easily put together to form a *secure* storm or common tent. In conclusion, the Board is of the opinion that if "Farrow's Portable Combination Shelter, Storm, and Common Tent" is adopted, it will prove a valuable addition to the camp-equipage now issued. See *Tent*.

FARROW KNIFE-TROWEL AND TENT-PEG.—An invention designed to combine the intrenching-tool and a great many other necessary articles for field-equipment. The scabbard (one edge sharp) is of the same shape and size as the blade of the trowel-bayonet. A knife (rasp, saw, or any other article required by the particular man who uses it) enters the scabbard and is retained in position by means of a small but strong spring. The back edge of the scabbard is prepared so as to form a convenient wrench, screw-driver, shell-extractor, etc.; while to the upper and outer edge is attached a small neck and ring, so as to convert it into a suitable tent-peg or picket-pin when driven into the ground. While on the march the scabbard, with knife encased, is hooked to the belt and worn at the side. For intrenching and chopping purposes the whole is unhooked and used. To use the knife it is simply drawn from the scabbard; and after arrival into camp, the scabbard (with or without the knife) is driven into the ground wherever needed, as a picket-pin or tent-peg. Each soldier might be provided with a *knife-trowel*, to be worn on the body; and each cavalryman, packer, etc., might have attached to his saddle an additional trowel, containing a rasp, saw, etc.

FASCES.—Bundles of rods usually made of birch, but sometimes of elm, with an axe projecting from the middle of them, which were carried before the Chief Magistrates of ancient Rome, as symbols of their power over life and limb. They were borne by the Lictors, at first before the Kings; in the time of the Republic, before Consuls and Prætors; and afterwards before the Emperors. Their number varied, a Consul having twelve, and a Prætor six; but within the city only two. Valerius Publicola introduced a law that within the city the axe was withdrawn, except in the case of a Dictator, who was preceded by 24 Lictors, bearing as many fasces. Publicola also made the fasces be lowered at the assemblies of the people, as an acknowledgment of their supreme power.

FASCINE REVETMENT.—To form a fascine revetment, the first row of fascines is imbedded about half its thickness below the tread of the banquette, and is secured by means of the anchoring-stakes, and also by several stakes driven through the fascine itself about 12 inches into the earth. The knots of the ties are laid inside, and the earth of the parapet is well

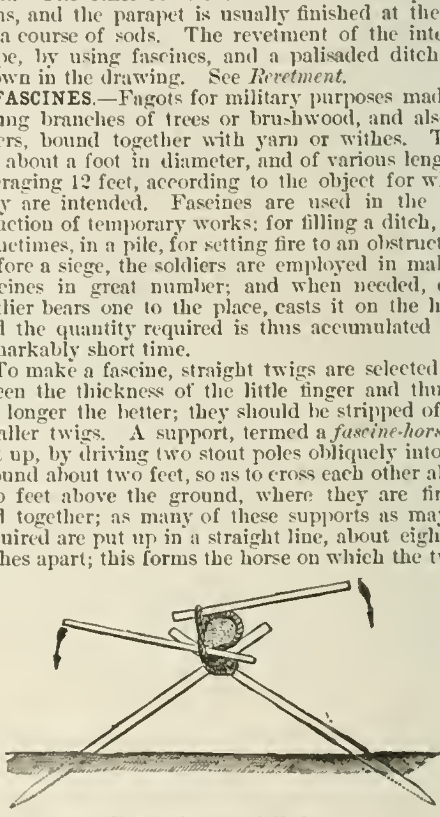


Fascine Revetment and Palisaded Ditch.

packed behind the fascine. A second row is laid on the first, so as to give the requisite interior slope; it should break joints with the first row, and be connected with it by several stakes driven through them both. The other rows are laid with similar precautions, and the parapet is usually finished at the top by a course of sods. The revetment of the interior slope, by using fascines, and a palisaded ditch are shown in the drawing. See *Revetment*.

FASCINES.—Fagots for military purposes made of young branches of trees or brushwood, and also of osiers, bound together with yarn or withes. They are about a foot in diameter, and of various lengths, averaging 12 feet, according to the object for which they are intended. Fascines are used in the construction of temporary works: for filling a ditch, and sometimes, in a pile, for setting fire to an obstruction. Before a siege, the soldiers are employed in making fascines in great number; and when needed, each soldier bears one to the place, casts it on the heap, and the quantity required is thus accumulated in a remarkably short time.

To make a fascine, straight twigs are selected, between the thickness of the little finger and thumb, the longer the better; they should be stripped of the smaller twigs. A support, termed a *fascine-horse*, is put up, by driving two stout poles obliquely into the ground about two feet, so as to cross each other about two feet above the ground, where they are firmly tied together; as many of these supports as may be required are put up in a straight line, about eighteen inches apart; this forms the horse on which the twigs



Fascine-horse and Choker.

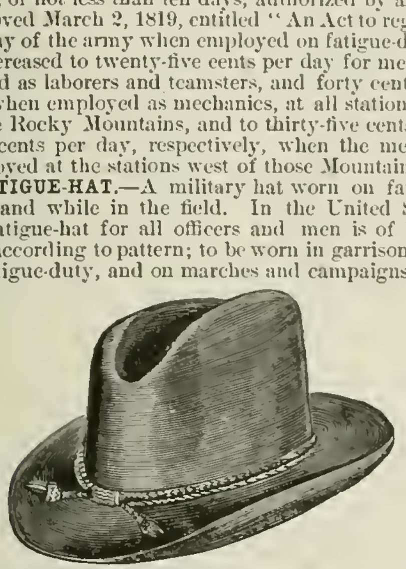
are laid to be bound together. A machine, termed a *fascine-choker*, is formed of two stout levers about five feet long, connected near their extremities by a chain or strong cord, which should be long enough to pass once round the fascine, and be drawn tight by means of the levers. The twigs are laid on the horse with their large and small ends alternating; the choker is applied to bring them together, and they are bound by wire, or by withes made of tough twigs, properly prepared by twisting over a blaze, so as to render them pliable. The ties are placed 12 inches apart, and every third or fourth one should be made with an end about three or four feet long, having a loop at the extremity to receive a stake through it. This stake is termed an *anchoring-stake*, its object being to secure the fascine very firmly to the parapet. See *Fascine Revetment*.

FASTNESS.—A well fortified place; a stronghold; a fortress or fort; a castle, etc.

FATIGUE-CALL.—A particular military call, sounded on the bugle or drum, by which soldiers are called upon or assembled to perform fatigue-duties.

FATIGUE-DUTY.—The term *fatigue* is applied to the labors of military men distinct from the use of arms. Extra pay is provided for all soldiers performing the authorized fatigue-duties. The following law was enacted as early as 1854: That the allowance of soldiers employed at work on fortifications, in surveys, in cutting roads, and other constant labor, of not less than ten days, authorized by an Act approved March 2, 1819, entitled "An Act to regulate the pay of the army when employed on fatigue-duty," be increased to twenty-five cents per day for men employed as laborers and teamsters, and forty cents per day when employed as mechanics, at all stations east of the Rocky Mountains, and to thirty-five cents and fifty cents per day, respectively, when the men are employed at the stations west of those Mountains.

FATIGUE-HAT.—A military hat worn on fatigue-duty and while in the field. In the United States the fatigue-hat for all officers and men is of black felt, according to pattern; to be worn in garrison only on fatigue-duty, and on marches and campaigns. In



United States Regulation Fatigue-hat.

extreme southern latitudes, in summer, Commanding Officers are authorized to sanction, on duty, the straw hat, to be bought, out of the pay of the soldier, of the local merchant or trader. Whenever straw hats are worn by enlisted men, the officers must in like manner wear them. The wearing of the fatigue-hat is generally optional. The forage-cap may replace it.

FAUCHARD.—A formidable weapon of the sixteenth century. It resembled a very large razor-blade fixed to the end of a staff.

FAUCRE.—A kind of hook which served to fix the heavy lance to the cuirass. It was used in the twelfth century, when tournaments became a regular practice and when very heavy lances were employed.

FAUDES.—A species of kilt of armor, or iron petticoat. It is known as *taces* in England.

FAULCON.—A very small cannon employed by the ancients. See *Falconet.*

FAULX.—An instrument very much resembling a scythe. It was often used to defend a breach, or to prevent an enemy from scaling the walls of a fortified place. This weapon was first resorted to with some success when Louis XIV. besieged Mons. On the surrender of that town, large quantities of faulx, or scythes, were found in the garrison.

FAUSSE-BRAIE—FAUSSE-BRAYE.—A low rampart encircling the body of a place, and raised about three feet above the level ground. This work has been mostly discarded by modern engineers, except when used in front of curtains, under the name of *tenailles.* The French engineers gave this title to the work, as an adaptation from the Italian term *fossa brea*, which had its origin from the fausse-braie being commonly in the ditch, in front of the main wall. The fausse-braie had the advantage of giving an additional tier of guns for defensive purposes, but the still greater disadvantage of affording facilities for the scaling of the parapet. In many of the places constructed before Vauban's time there was a fausse-braie, enveloping the enceinte and connected with it. This work was suppressed by Vauban, who was the first to use the tenaille in its place.

FAUSSTOURNIER.—A description of tournament practiced at the close of the twelfth century.

FECIAL.—Pertaining to heralds, and the denunciation of war to an enemy; as, fecial war.

FEDERAL GOVERNMENT.—A body-politic composed of the people of several different and in some respects independent States, over which, in its own prescribed sphere, it exerts a supreme authority; while outside of that sphere the States and the people thereof are sovereign within their respective jurisdictions. The character of a Federal Government varies with the extent of its powers. The first form of Federal Government established in this country was that of the "Articles of Confederation," adopted during the War of the Revolution, July 9, 1778. The separate Colonies, finding some form of Central Government indispensable to the efficient prosecution of the War of Independence, gave a reluctant consent to those Articles, which, while the war lasted and all felt the presence of a common danger, worked tolerably, though not without some embarrassing friction arising from notions of Colonial or State Sovereignty. But after the Independence of the country was established, and the pressure of a common danger no longer existed, there was a disposition to exalt the State, and to depreciate the National Authority, which to some extent was regarded as a burden. The National Government had no judicial tribunal to make an authoritative exposition of its powers, and no executive officers to enforce its decrees; it was entirely dependent upon the voluntary action of the States for means to carry on its operations; so that, in the language of Washington, it was "little more than a shadow without the substance," and "Congress a nugatory body, their ordinances being little attended to." There was, in short, an utter want of all coercive authority on the part of the Government to carry into effect its own constitutional measures. The embarrassments growing out of this state of things were endured till 1787, when a Convention of Delegates from the several States was held in Philadelphia "for the purpose of revising the Articles of Confederation and reporting to Congress and the several Legislatures such alterations and provisions therein as shall, when agreed to in Congress and confirmed by the States, render the Federal Constitution adequate to the exigencies of the Government and the preservation of the Union." The Convention encountered many difficulties arising from diversities of opinion among its members, and from conflicting local interests, but finally succeeded in framing a Constitution which the people of the several States finally ratified, and which, with various Amendments, has continued to this day. From the time of its adoption different theories of interpretation have prevailed, and these conflicting theories, to a greater or less extent, have determined the character and aims of political parties. It has been contended on the one side that the Union was merely a league between the several States in their organized capacity, and that each State had the right, at its pleasure, of withdrawing therefrom. On the other side it has been held that the Union, instead of being the creation of the States, as such, was formed by "the people of the United States," acting indeed through their respective State Organizations, but still as citizens of a common nationality. According to this theory no right of secession on the part of a State has any existence, but it is the right and the duty of the National Government to maintain the Union by force. This question was brought to an issue in the late Rebellion, the slaveholding States seeking to exercise the assumed right of secession for the protection of slavery, and the non-slaveholding States taking up arms for the defense of the Union. The results of the war are generally regarded as a vindication of the anti-secession theory, though there are still some disputed questions concerning the relative powers of the National and State Governments. See *Constitution.*

FEED-DRUM.—The contrivance by which the supply of cartridges to certain machine-guns is made. In the Gatling gun it consists of a metal framing of cylindrical shape, having twenty divisions or slots around its circumference, radiating from the center. Each division contains twenty cartridges, placed one above the other in a horizontal position. A hole in the center of the drum fits over a pin on the hopper-plate. The cartridges are fed to the carrier below, and thence to the barrels. The cartridges pass to the hopper through an aperture at the bottom of each division of the drum. On the bottom face of the drum is a projecting rib, which fits into a slot on the hopper-plate, to steady the drum when firing. On its lower periphery the drum has a series of thumb-lugs by which it is revolved. A small brass weight in each division is caused to bear upon and slide down a groove provided for it, so that it follows the cartridges as they descend, and prevents their becoming choked in the divisions.

To fill the feed-drum, invert it and unlock it, turn the bottom plate until the hole in the plate comes directly over a division of the drum, then raise the brass weight and fill in the cartridges regularly, the bullets being placed toward the center of the drum, letting the weight descend slowly until the division is full. Proceed in like manner with the remaining divisions; then lock the plate and place the drum upright. The improved feed lately devised has not only greatly increased the direct fire, but is of inestimable value in enabling the gun to deliver high angle or mortar fire so as to drop the balls on men behind intrenched positions at all distances from 200 to 3500 yards with deadly effect. Tables of distances and elevations have been established to obtain with certainty the above result. Experiments with the gun have proved that bullets so discharged come down nearly perpendicularly, and with force sufficient to penetrate from 2 to 5 inches of timber. With this new feed there is no possible chance of the cartridge jamming, even when the gun is used by inexperienced men. It is beyond doubt the most valuable improvement at any time made in machine-guns. See *Gatling Gun.*

FEIGNING DISEASE.—A ruse much practiced in the Army and Navy, and also by convicts and others anxious to escape from discipline or procure a discharge from compulsory service. In the Army it is technically called *malingering.* The detection of feigned disease, of course, necessarily belongs to the highly educated Physician, and is impossible without a thorough knowledge of the reality, unless, indeed, the imitation be very coarse and badly studied. The diseases most commonly simulated are epilepsy, catalepsy, convulsions, blindness, deafness, palsy, insanity, indigestion, neuralgia, rheumatism, palpitation of the heart, and generally all disorders which may exist without leading to any distinct external appearances. Ulcers of the legs, however, have often been made, and kept open artificially through the application of irritant substances; and vomiting or coughing up of blood is very easily simulated, if the supposed patient can get access to the necessary materials in the slaughter-house or elsewhere. The detection of such impostures is easy or not according to the opportunities and knowledge and skill of the deceiver, as compared with those brought to bear on the discovery of the fraud. Many men in the public services, and women affected with hysteria, have become so expert as to deceive even men of high character and skill. There is one instance on record in which a man submitted to successive amputations of the arm upwards nearly to the shoulder, for an ulcer produced and kept open at will by local applications; and a case was some time ago recorded by Dr. Murchison in the *Medico-chirurgical Transactions*, in which there is no reasonable doubt that a large opening into the stomach was the result of caustic substances deliberately applied to the abdomen, with the view of exciting sympathy.

FEINT.—1. In military or naval matters, a mock attack or assault, usually made to throw an enemy off his guard against some real design upon his position. 2. In fencing, a seeming aim at one part when another is intended to be struck. See *Fencing.*

FELLOES.—The parts of a wheel which form its circumference. The felloes fulfill the following offices: 1. They furnish a secure seating for the head of the spoke. 2. They connect spokes and tire rigidly together. 3. They support and stiffen the tire, acting as a beam between each pair of contiguous spokes. The felloes are made of timber having a long straight grain or fiber. Each felloe should be so restricted as to its length compared with its depth, that the tangent to the inner arc, or *bosom,* at its central point shall not intersect the outer arc, or *sole.* By this provision the interior fiber at the center of the felloe spans its entire length, contributing its support to the weakest parts, which are at the extremities. The tongue-holes for the spokes must be separated far enough from each other and from the ends of the felloe to allow of a sufficiency of intervening material to withstand all pressures and wrenches from the tongues and adjoining felloes without splitting. Experience has proved that the number of felloes in a five-foot wheel can safely be limited to *six*, each of which is enabled to receive two spokes without endangering its strength. One bolt passing through each felloe and the tire is sufficient to prevent side-shifting. See *Wheel.*

FELL RAILWAY.—The railway under this name was well known to travelers proceeding to or returning from India, as it was the only means of going over Mont Cenis, in Italy, before the tunnel was bored through the mountain. This nature of rail has been found useful during war-time, and did good siege-service during the Franco-German War. The gauge is 18 inches. Each truck carries three tons. Five hundred unskilled workmen can lay a mile in a day.

FELTRE.—A cuirass made of strong woolen cloth, much worn in early times by the Romans and others.

FENCE.—Self-defense by the use of the sword; the art and practice of fencing or sword-play.

FENCIBLE.—1. A soldier enlisted for the defense of the country, and not liable to be sent abroad. 2. Capable of being defended, or of making or affording defense. See *Fencibles.*

FENCIBLE LIGHT DRAGOONS.—A body of cavalry raised voluntarily in various Counties of England and Scotland in 1794 to serve during the war in any part of Great Britain. This force was disbanded in 1800.

FENCIBLES.—Regiments formerly raised for local defense, or at a special crisis and for a limited time. The officers had the same rank as officers of militia, according to the dates of their respective commissions. The only English regiment now bearing this title is the Royal Malta Fencible Artillery.

FENCING.—The art of defending one's own body or assailing another person's in fair fight by the aid of a side-weapon—i.e., by a sword, rapier, or bayonet. Technically, fencing is usually limited to the second of these; and works on the art touch only on attack and defense with the foil in pastime, and the rapier in actual personal combat. The objection formerly existed that instruction in fencing encouraged a propensity to dueling; but as that absurdest of absurd customs has entirely ceased to demand its annual victims, no such objection now holds. Fencing may therefore be safely learned and taught as an elegant and manly accomplishment, developing gracefulness and activity, while it imparts suppleness to the limbs, strength to the muscles, and quickness to the eye. This regards fencing with the foils (the rapier has disappeared with the duels which employed it); but instruction in fencing with the sword and bayonet, while conferring the same advantages, has in addition the recommendation of helping to fit the student for taking an active part in any general national defense that political circumstances might render necessary. The foil is a circular or polygonal bar of pliable and very highly tempered steel, mounted as any other sword, and blunted at the point by a "button," to prevent danger in its use. From its nature, the foil can only be employed in thrusting, and, being edgeless, it can be handled without liability to cutting wounds. The length of the blade should be proportioned to the height of the person using it—31 inches being the medium length for men, and 38

FIG. 1.

FIG. 2.

FIG. 3.

inches from the hilt to point the maximum allowable. As a protection against accidental thrusts, the face is generally guarded by a wire-mask. The two portions of the blade are known as the "forte" and the "foible;" the first extending from the hilt to the center, and the other from the center to the point. In fencing there are three *openings* or entrances—the *inside*, comprising the whole breast from shoulder to shoulder; *outside*, attackable by all the thrusts made above the wrist on the outside of the sword; and the *low parts*, embracing from the armpits to the hips. For reaching and guarding these entrances there are five positions of the wrist—prime, seconde, tierce, carte (quarte), and quinte. The most important, and those to commence with, are carte and tierce, from which are derived the subordinate positions of carte over the arm, low carte, and flanconnade or octave. To *engage* is to cross swords with your adversary, pressing against his with sufficient force to prevent any maneuver taking you unawares. To *disengage* is to slip the point of your sword briskly under

FIG. 4.

his blade, and to elevate it again on the other side, pressing in a direction opposite to that of the previous case. The *guard* in each position is a passive obstruction to the opposing *thrust;* the *parade* is an active obstruction in which the guard is first assumed, and the blade then pressed outward or inward by a turn of the wrist against the adversary's sword, so that when thrust at your body it shall be diverted from its aim and held off. The parade may therefore be regarded as a mere extension of the guard. If the parade were called the "parry," it would convey its meaning more readily to English ears. Another and perhaps more appropriate name for thrust is the "lunge" or "longe," as the thrust is almost always accompanied by a lunge forward of the right foot, to give at once greater force and longer command to the blow.

The fundamental principle of fencing consists in the execution of the right arm, the longe, the recovery; advancing and retreating quickly; and lastly, not least, a good opposition, which is one of the most essential things, as you are guarded at least on one

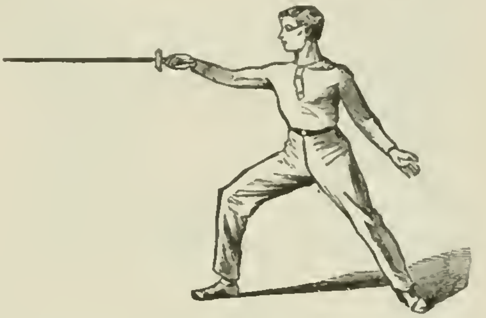


FIG. 5.

side. This will also give the advantage of knowing what your adversary intends doing, which you must endeavor to discover by the feel of his foil.

First Position of the Body.—Place the right heel against the left ankle, so as to form a right angle with both heels, the foil to be held in the left hand under the hilt with the thumb and fingers, the right hand straight on the outside of the right thigh, shoulders square and pressed rather backward, eyes turned toward the adversary, showing the right breast to the front, without constraint. (Fig. 1.)

Second Position.—Bend the right arm as high as the elbow, and at the same time bring it across the body; take hold of the foil, thumb stretched along the convex. In this movement the body must be kept quite steady, shoulders square, eyes front, head up without appearing stiff, knees perfectly straight, waist in. (Fig. 2.)

Third Position.—Raise both hands above the head, holding the button of the foil with the thumb and first finger of the left hand, turn your eyes to the right, so as to see your opponent full in the face. (Fig. 3.)

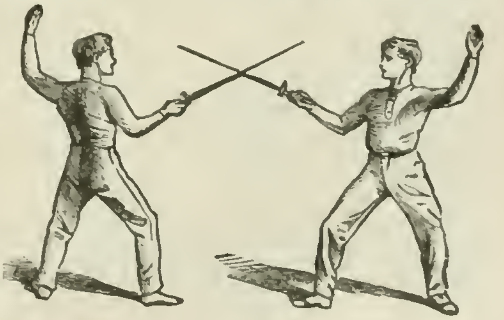


FIG. 6.

Manner of Holding the Foil in Hand.—Let the concave of the handle rest in the palm of the hand, the thumb stretched along the convex, the first finger about half an inch in advance of the thumb; the foil should only be held firm in the hand when parrying or thrusting, otherwise the fingers and thumb will get stiff from grasping it too long.

On Guard in Carte.—Bend both knees together until they are in a perpendicular line with the toes; step out with right foot in a direct line from the left ankle, about twenty-two inches or more, according to the length of the legs; keep the left arm up and bent, so as to form a half-circle as high as the head, palm of the hand turned toward the left face; keep the body upright, the weight to be kept equally on both legs; bring the point of the foil down to the height of your adversary's left eye. This is the engage of carte; arm bent and the elbow drawn inward, the hand as high as the center of the chest. (Fig. 4.)

The Half-longe.—1. Straighten the right arm with-

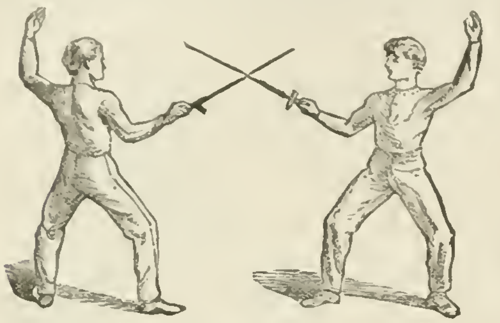


Fig. 7.

out moving the body, point of the foil as high as the chest of the opponent, hand as high as your face. 2. Throw the left hand backward, at the same time press the shoulder well back, palm of left hand to the front, about four inches from the thigh. 3. Straighten the left knee and incline the weight of the body forward on the right, without moving the foot from the ground. *To Recover.*—1. Bend the left knee. 2. Throw the left arm upward to the position of the guard, bear the weight of the body again equally on both knees, right arm bent, elbow turned inward; stand firm on guard without appearing stiff; head held easy and upright.

The Longe.—1. Extend the right arm, direct the point of your foil to the height of your chest, longe in carte, looking over the right arm, the hand as high as your face. 2. Throw the left hand backward to within four inches of the left thigh, palm of the hand to the front; press the shoulders well back. 3. Straighten the left knee and keep the foot flat on the ground. 4. Longe forward in a direct line from the left ankle about forty inches or more, according to the length of the limbs, until the right

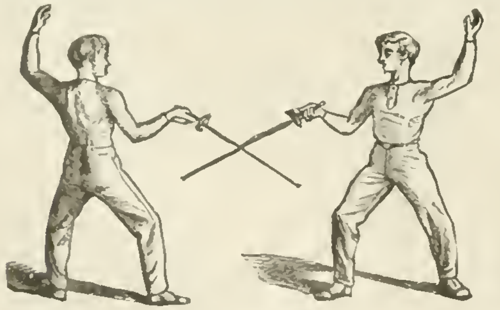


Fig. 8.

knee is in a vertical line with the instep, toes turned out. (Fig. 5.) These four motions should be repeated often, so as to give freedom of action to all the joints. *To Recover.*—1. Bend the left knee back. 2. Throw the left hand upward to the position of the guard, palm of the hand turned inward toward the left face, arm bent. 3. Bring the right foot up to the guard, supporting the weight of the body equally on both knees. 4. Bend the right arm, nails upward, point opposite the face, hand as high as the chest, elbow rather inward, head kept up.

To Advance and Retire.—Being on the guard, to *advance*, take one step forward with the right foot, about twelve inches, bring up the left foot directly, keeping the same distance between both feet, as if making one movement with both; the knees equally bent, the body held upright, eyes fixed on the opponent or object in front. To *retire*, take one pace back with the left foot, bringing the right foot up immediately, at the same time beat once with the flat of the right foot firmly on the ground. The distance

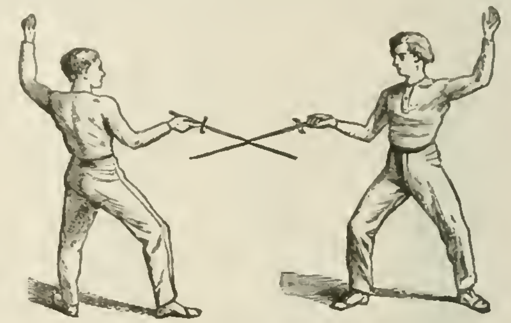


Fig. 9.

in walking backward should be longer than the advancing by two or three inches, taking care that the weight of the body is kept equally on both feet; the left breast should be turned slightly toward the adversary. Having practiced these movements frequently, finish by beating twice with the right foot, bringing up the left foot, and right hand under the chin, lastly straightening the right arm on the right side.

The Engage of Carte—Inside Guard High.—Being engaged in carte with an adversary, turn the nails upward, cross foils about nine inches from the button: this half of the foil is called the *foible*, from being the next part to the end; the other half is termed the *forte*, or part next the hilt. Oppose the opponent's foil sufficiently to prevent him from touching you in the engage, keep the right arm bent inward, point of your foil opposite your adversary's face, right arm as high as your chest. (Fig. 6.) If your opponent does not cover himself in the engage, straighten your arm, lower the point to his chest, longe in carte, looking over the right arm, hand as high as the face, recover and engage in carte, crossing foils as before.

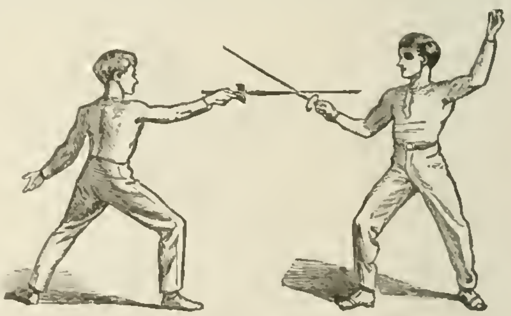


Fig. 10.

The Engage of Tierce—Outside Guard High.—This being the opposite guard to carte, it only differs from it in the position of the hand, nails of which are turned downward. Engaged in tierce, join foils as in carte; if your adversary is not well covered in the engage, straighten your right arm by lowering the point to his chest, longe in tierce, looking inside the arm, shoulders pressed well back, left foot firm on the ground, left knee straight, the body not thrown forward but rather upright; recover in tierce. (Fig. 7.)

The Guard of Half-circle—Inside Guard Low.—The half-circle guard is generally used against the thrust of seconde and low carte. The guard is generally taken in the following manner: Raise the hand as high as the left shoulder, nails upward, the elbow turned well in toward the body, the foil to be held firm in hand and opposed to your adversary, the point as low as your opponent's waist. If an opening should occur, raise the point and return carte. (Fig. 8.) The guard of octave is the opposite guard to the half-circle, and is used against the thrust of octave; it also prevents the adversary from counter-disengaging.

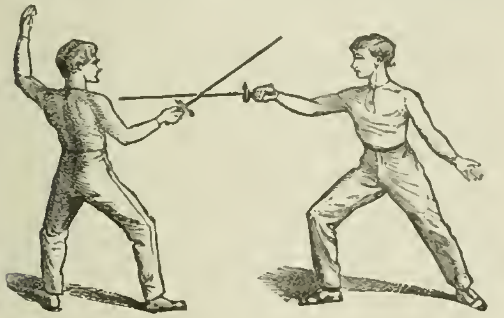


FIG. 11.

Raise the hand as high as the chest, keeping the point as high as the lower part of your opponent's chest. This is a very useful parry in returning the thrust of low carte.

The Disengage from Carte. — If your adversary presses your foil, lower your point to within about two or three inches of his hilt, at the same time passing it to tierce, straighten the right arm, and longe; recover in carte. (Fig. 9.)

The Feint of One, Two.—Being engaged in carte, if your opponent takes the guard of tierce when you disengage on him, return back to carte and longe, making the movement quickly from the fingers, not from the shoulder; right arm quite straight, nails upward, look over the right arm; recover in carte. (Fig. 10.) *The Feint of One, Two, Three.*—Engage in carte as before, disengage to tierce, again in carte. In both cases raise the point of your foil as high as your opponent's face, arm kept straight, return again to tierce, point to the chest of your adversary, and longe in tierce, looking inside your arm, shoulders pressed well back, body upright; recover in carte. (Fig. 11.)

The Disengage from Tierce.—Engage in tierce. As

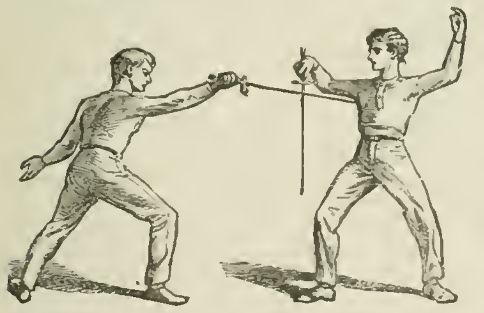


FIG. 12.

soon as your opponent presses your foil, lower your point, straightening the arm, at the same time pass your foil to carte, longe with the knuckles turned upward, taking care that the left foot does not quit the ground; recover in tierce. *The Feint of One, Two.*—Engage in tierce. Disengage to carte, pointing to the face of your adversary, arm straight, the body kept steady; the moment your opponent takes the simple guard of carte, return to tierce, longe, looking inside the right arm; recover in tierce. *The Feint of One, Two, Three.*—Being engaged in tierce, disengage to carte, again to tierce, extending the arm in the first disengage; finding that he takes the simple guards each time, return to the carte, longe, looking over the arm, left knee always being kept straight in the longe; recover in carte.

Wrist Practice.—An excellent practice for the wrist is for two persons to practice the counters of carte and tierce. This is done in the following manner: Being engaged in carte, your adversary disengages on you, take the counter of carte, and disengage on him without touching, unless, by mutual agreement, he

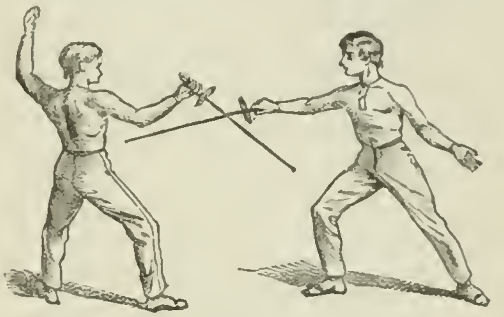


FIG. 13.

takes the counter of your disengage; keep repeating this for some time; then engage in tierce, the opponent disengages, take the counter of tierce, disengage on him; continue this also for some time, and change again to counter-carte. These practices will soon make the wrist supple and strong—the two essential things for fencing.

The Parade of Prime.—Being engaged in tierce, your adversary tries to get in by main force; bend your arm and wrist, turning the nails downward at the same time, raise the hand as high as your chin, drawing the arm inward as you raise the hand, the point of your foil directed toward the lower part of the chest of your adversary; parry and longe in seconde, recover quickly in tierce. (Fig. 12.)

Thrust of Sixte. — After having parried prime, should your opponent keep his hand low in trying to get in by force in tierce, turn the knuckles upward quickly, bring the point over his arm, thrust sixte over the arm by binding his foible with your forte: this must be done by a quick turn of the wrist.

The Parade of Seconde.—Engaged in tierce, if your adversary should drop his point, parry the seconde by

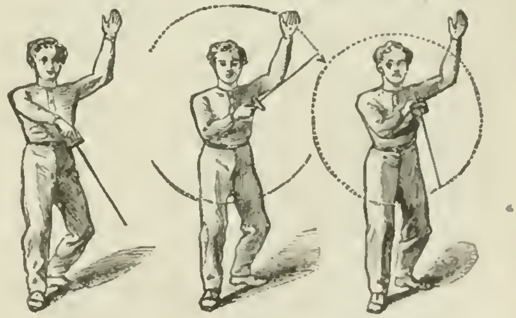


FIG. 14.

giving a dry beat on the foible of his foil with the forte of yours, nails downward, hand opposed, so as to prevent him touching you in the longe, point to the lower part of his waist, holding the head well up, the body not to be thrown too much forward, otherwise you cannot recover quickly; recover in sixte. (Fig. 13.)

The Feint of Seconde.—Being engaged in tierce, drop your point under the hilt of your opponent, principally with the fingers, nails downward, but without lowering the hand, return directly back again, longe by turning the nails upward in sixte, over the arm, or return back to seconde again, longe and recover in tierce. This is called the feint of seconde and tierce.

The Parade of Quinte.—This parade is used in the same side as carte inside guard, and taken in the following manner: The hand as high as the breast, nails turned downward, parry and longe in seconde or carte over the arm. The parry is mostly taken when the adversary thrusts low. It is also a very quick return thrust when your adversary keeps his hand too low, or drops the point to feint for the lower part of your body.

The Parade of Sixte.—This parade only differs from tierce in the nails being turned upward instead of downward. The hand must be kept as high as the shoulder; point as high as your adversary's face if your opponent is not well covered, straighten the arm, longe with the nails upward, recover; if he presses, disengage in carte. The feint of one, two, and one, two, three, is generally made from this position.

The Parade of Counter-carte.—Having joined foils in carte, nails upward, as soon as your adversary disengages, follow his foil by making a small circle until you meet it again in carte; if he disengages a second time, take the simple guard of tierce. This is one of the best and safest parries in fencing, as it stops most of the feints. Being engaged in tierce, if the opponent feints one, two, take the counter of carte in the same manner as before; should he disengage a third time, take the guard of tierce; if he low-

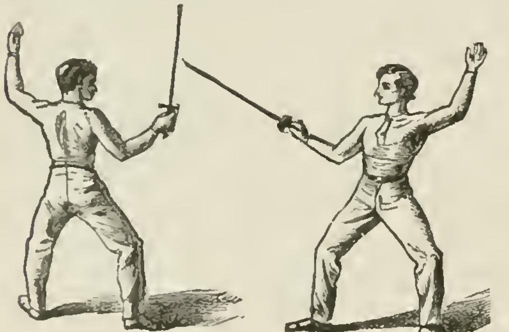


Fig. 15.

ers the point, take the half-circle, returning again to carte. (Fig. 14.) When your adversary stretches his arm to thrust, give a beat on the foible of his foil with the forte of yours, so as to make an opening for your thrust. This may also be done in the counter of carte, when your opponent is not too close.

The Parade of Counter-tierce.—This parade is performed similarly to the counter of carte, but the nails must be downward. Being engaged in tierce, if your adversary disengages, follow his foil in a circular manner until you meet it again in tierce; if he disengages a second time, take the simple guard of carte. Should he make the feint of one, two, without stopping, take the counter of tierce, as before, but be careful not to be too near, as the guard is only safely taken when out of distance: If he disengages after having feinted one, two, take the simple guard of carte. To parry tierce, turn the nails downward, keeping the foil firm in hand, to prevent being disarmed. When your opponent stretches his arm to thrust, give a dry beat on the foible of his foil with your forte, so as to throw it out of the line. Direct your point to his chest, longe either in tierce or in seconde.

Half-circle Parade.—The half-circle is generally used after having parried tierce against the thrust of seconde or low carte. For this purpose raise the hand as high as the shoulder, bend the arm, nails turned well upward, elbow drawn inward, parry and point rather low, longe in carte. To perform the counter of half-circle;—having crossed foils in half-circle, which is only done in making an assault, your opponent passes his foil over yours; follow by making a circle till you meet him again in half-circle; if he disengages again, take the guard of octave or seconde, longe and recover in tierce. Sometimes the circle may be made twice with success by keeping the hand well up, holding the foil firmly. (Fig. 14.)

The Parade of Octave.—The octave parade is the opposite guard to half-circle, and is taken to prevent the opponent from getting in by force in the lower part of the body in octave or seconde. Keep the hand as high as the center of your body, straighten the arm slightly so as to oppose your adversary, point of the foil rather low, parry and longe in tierce or octave. To perform the counter of octave, having opposed your adversary in octave, he may disengage over your foil; therefore follow his foil, immediately describing a circle until you meet his foil again in octave, taking care to keep the hand well up. If he passes over a second time, take the guard of half-circle or quinte, longe in low carte, keeping the head up.

The Cut over the Point from Carte to Tierce.—Engage in carte. If the opponent holds his hand low with the point high, raise your wrist sufficiently to clear the foil of your adversary without exposing your body. Cut with the foil over his point until it hits the center of his chest. If your adversary parries tierce, as soon as you see him take the guard, disengage under his arm by passing your point under the wrist. Longe in carte. The cut and longe should be made simultaneously. (Fig. 15.) The cut from

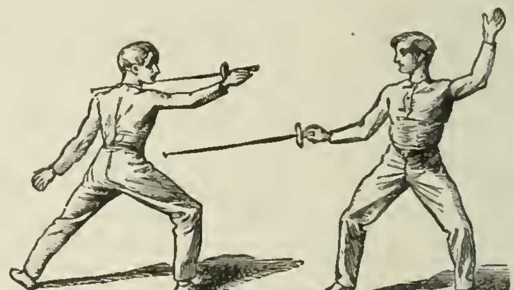


Fig. 16.

tierce to carte is made in the same manner as carte, but the longe must be in carte inside the arm; be careful that the body is well covered, and not run the risk of being hit at the same time; keep the body a little backward. If the adversary takes the guard of carte when you cut, disengage to tierce by passing your foil quickly over his wrist, arm quite straight, longe in tierce.

The Disengages.—The disengages are made when an adversary takes the simple guards, or leaves himself uncovered on either side; however, care must be taken that he does not thrust at the same time as you disengage, thereby both hitting at the same time. This can be avoided by keeping the hand opposed to the adversary either in carte or tierce, whichever you may be engaged in at the time of making the disengage, the one, two, or one, two, three. The disengage is also advantageously taken when the adversary advances or retreats. Allow him to take one pace backward, opposing his foil on either side; lower the point of your foil; longe, covering your body in carte or tierce, whichever you may be engaged in at the time. Should your opponent advance, retreat one pace, keeping a good opposition; disengage as before, longe and recover quickly on guard. The feint of one, two, and one, two, three, can be made in the same manner.

The Salute.—The salute, previous to making an assault or loose play, as it is termed, is an established form of politeness before fencing for hits; it is also an excellent practice, as it prepares the body to undergo the more energetic movements in the assault. Begin in this manner: 1. Stand, as in Fig. 1, with the foil in the left hand. Salute by presenting the right hand to your adversary as high as the chin, palm of the hand upward. 2. Bring the hand across the body, as in Fig. 2. 3. Raise both hands above the head, as in Fig. 3. 4. Step out on guard, in tierce, with your foil out of the line of your adversary's body, your opponent doing the same; now both beat twice with the right foot, leaving the body exposed; ask the adversary to thrust first, upon which he brings his point in front of your body, and longes in carte, but without touching your body. The distance of his point should be at least one inch from your breast. This is called measuring distance. Your adversary having recovered, do the same by bringing the right foot up to the left ankle, dropping the left hand, the right hand brought under the chin. From this position salute, first in carte, by turning the eyes to the left simultaneously with the foil; bring the foil under the chin again; salute in tierce, bringing the foil back once more; salute your opponent by presenting your point in front of his face; then by a circular movement made inward with both hands get on guard in carte.

Thrusting Carte and Tierce.—Engaged in carte, it being the adversary's turn to thrust first, he disengages in tierce, you parry tierce, and turn the hand to seconde, nails down, by dropping the point; your opponent's foil is now over the left shoulder, holding with the fingers and thumb very slightly. (Fig. 16.) Six disengages are to be made, that is to say, three on each side, finishing in carte. When your adversary gets on guard in tierce, engage with the foil, at the same time beating once with the right foot; now he disengages to carte, parry carte, and turn your foil in half-circle, nails up; his foil is now over the right shoulder. When he gets on guard, engage again in carte, beating once with the right foot. When he has completed the six disengages, he finishes by feinting one, two, without longeing, recovers in tierce, leaving his body exposed, bringing the right foot up to the left ankle, left hand down to the side.

Disengaging Carte and Tierce.—Being your own turn to thrust, your opponent asks you to do so. Begin by bringing the foil in front of your adversary's body, arm quite straight, longe in carte within one inch of his chest, recover and both go through the salute as before; engage in carte. Make three disengages on each side as before, finishing in carte, each beat twice with the right foot, bring the right foot up directly to the left ankle, take one pace backward with the left foot, resting the pommel of the foil on the right knee, the foil perpendicular, body upright; beat twice again, bring the left foot up to the right heel, right hand under the chin, go through the salute again, finish by describing a circle with both hands, resting the right hand on the knee; beat twice with the right foot, bring the right foot up to the left ankle, hand under the chin, and drop it to the right side over the knee, left hand down, after which put the mask on.

The Assault.—An assault with foils resembles an encounter with small-swords. All the thrusts and parries learned in the lesson should be brought into play, the object of each fencer being to discover the intentions of his adversary and conceal his own. Never fence without having a mask on, also a jacket of leather or some strong material to prevent accident; also see that the foils are properly buttoned. When you put yourself on guard, endeavor to discover whether your opponent has a mind to attack or defend; for this purpose, take one step backward, showing your point opposite his chest; if he thrusts, parry carte by giving a beat on his foil; if engaged in tierce, parry tierce; should he make the feint of one, two, take the counter of carte; and so on. Try not to let your adversary know your intention by your eye; keep changing to avoid this advantage which you may give him. Never throw the head forward in longeing: by so doing you cannot recover quickly. Always take care to be covered in whatever side you are engaged: if in carte, cover the body to the inside; if in tierce, cover the body outside; observe the same rule in the low guards.

The Double Counters.—Engaged in carte, disengage to tierce, straightening the arm without longeing. If your adversary takes the guard of counter-carte, disengage again; should he take the counter a second time, double, following his foil, longe in tierce; for instance, by doubling counter-tierce, you deceive with a circle your opponent's counter-carte. Engaged in tierce, disengage to carte; straightening your arm, point to your opponent's chest, but be careful not to expose your body by inclining it forward; this should always be avoided. As soon as he takes the counter of tierce, double, and longe in carte; the same rule is to be observed in the lower guards; that is, if you are engaged in half-circle, disengage to octave; if your adversary takes the counter of half-circle, double and longe in octave, engage in octave, disengage to half-circle; if he takes the counter of octave or seconde, double circle and longe in half-circle or carte.

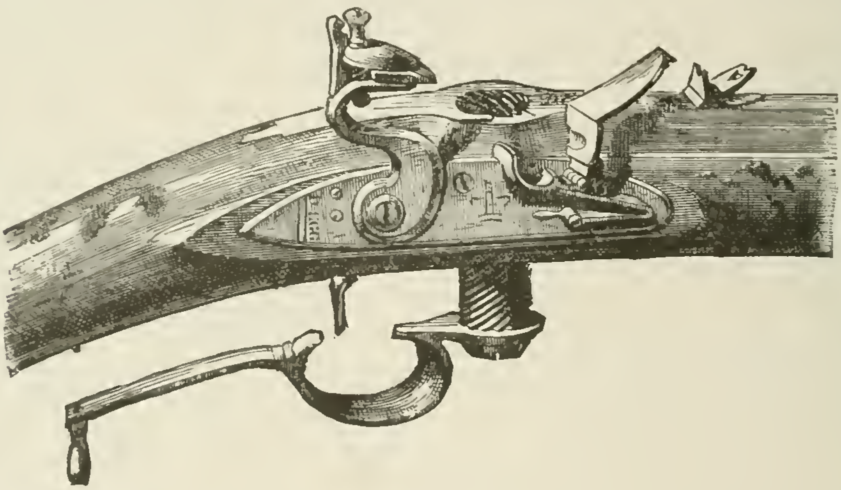
To Guard the Double Counters.—After having taken the counter-guard twice, not meeting with the foil of your adversary, take the simple guard on the opposite side; for example, being deceived in your double guard of counter-carte, take the simple guard of tierce or half-circle; being deceived in your double guard of counter-tierce, take the simple guard of carte; the same for the low guards. Being deceived in your double circle, take the guard of octave; being deceived in your double of octave or seconde, take the guard of half-circle or tierce, always continuing the guard until you meet with the adversary's foil. Another way of stopping the double movements is to take the guards of counter-carte and counter-tierce, or counter-tierce and counter-carte, without stopping; for the lower part of the body, take the guards of counter-circle and counter-octave, or counter-octave and counter-circle. This is an excellent practice to strengthen the wrist and make it supple.

In an article limited in length as this must necessarily be, it is impossible to give more than the merest outline of the various motions; but of course in actual practice there are endless variations of the different modes of attack and defense, which will be severally adopted according to the skill and option of the fencer. There is no finer indoor exercise than fencing, as the muscles in every limb are developed and strengthened by it. The great requirements for success are a steady eye and hand; a quick purpose, as quickly executed; and perhaps, above all, perfect equanimity of the temper. See *Bayonet-exercise* and *Sword-exercise*.

FENIAN SOCIETY.—A political association of Irish or Irish-Americans, the object of which is the overthrow of the English authority in Ireland and the establishment of a Republic. The etymology of the name has been the subject of some discussion. It is traced to the ancient Irish military organization called Fionna Eirinn, which took its appellation from the celebrated hero of Irish legend, Finn (or Fionn) MacCumhail. The accounts of this renowned body, with which the bardic literature of Ireland abounds, are most curious. It was designed as a National Militia, and its origin is ascribed, by Keating, to Sedna II., who was Monarch of Ireland about 400 years B.C. In time of peace it consisted of three bodies, each formed on the model of a Roman Legion, and consisting of 3000 men; but in war it was capable of being enlarged to any required limit. Candidates for enrollment were required to be of honorable family, to be irreproachable in morals, and to bind themselves to observe the laws of justice and morality; they were required to be of a certain height, and strong, supple, and vigorous of body; each being submitted, before enrollment, to an ordeal, in which his powers of speed, strength, endurance, and courage were tested by trial with his future comrades. The bardic accounts of some of those conditions are extravagant and amusing in the highest degree, but the generally historical character of the institution is unquestionable; and it subsisted until the reign of Carbry, son of Cormac MacArt, by whom the body of Fionna Eirinn was disbanded, and the members having, in consequence, transferred their allegiance to Mocorb, King of Munster, suffered an almost total extermination in the battle of Gavra, 284 A.D., which formed the theme of many a bardic poem from the days of Oisin (known in Gaelic legend as Ossian), son of Finn MacCumhail, downwards.

Adopting the name of this ancient military association, the modern Fenians (or Finians) are a secret association for the purpose of overthrowing the alien ascendency of the Saxon, and of restoring to the ancient Celtic population their legitimate status and influence in their native country. It had its first seat in America, where the Irish population has largely increased since the famine of 1846–47. Many of the emigrants being driven from their homes by arbitrary ejectment, or from inability to pay rent, carried with them a sense of fancied wrong, which prepared them for almost any enterprise which seemed to promise revenge. Others had been sympathizers, if not participators in the insurrection of 1848; and almost all were deeply imbued with general political and social discontent. By all these the prospect of a secret organization for the establishment of Irish independence was eagerly accepted. The most openly active seat of the organization was in the Western States, especially Chicago; but the movement was directed from New York, and it possessed ramifications in almost every old city of the Union. It was conducted by a Senate, and consisted of "Circles," each directed by a Center. The duty of the Centers was to enroll members, who bound themselves, generally by oath, "to be faithful to the Irish Republic as at present virtually established"; to instruct and practice them in military exercises; to raise funds for the purposes of the association, especially for the purchase of arms and munitions of war; and to extend the organization by every means at their disposal. Agents were sent into Ireland, and to the chief seats of the Irish population in England; and while the work of secret enrollment was industriously carried on in Ireland, measures were openly concerted in America, as well for the raising of funds by private contributions, as for the purchase of arms and military stores. Opportunely, too, for the purposes of the enterprise, the termination of the Civil War in America set free a large number of military adventurers who had served as privates or as officers in one or other of the American armies, and whose experience of service was turned secretly but most actively to account in the training of the young recruits enrolled in the Fenian Conspiracy in Ireland. Newspapers, moreover, both in America and in Ireland, were established or subsidized for the purposes of the Conspiracy; and journals, broadsides, ballads, and other inflammatory publications were largely circulated among the peasantry and artisans. Taverns, alehouses, and other places of entertainment were the ordinary places of meeting; and one of the most formidable of the plans of the Conspiracy was an organized attempt to seduce the Irish soldiers from their allegiance, and to prepare the way for their deserting to the ranks of Fenianism when it should have reached the expected degree of maturity. It became apparent, moreover, that in this, unlike almost all similar movements, pains were taken by the organizers to exclude the Catholic Clergy, by whom the Fenian Confederation had from the first been steadily resisted, from all knowledge of its character and objects, as well as of the names or number of its members in the several localities; and many of the most active of the leaders were distinguished by the freedom of their religious opinions, and by their unconcealed disregard of clerical authority.

FER.—A word figuratively used for a sword or a dagger; as in the phrase *manier le fer*, to wear the sword, to follow the profession of arms.



Ferguson Rifle.

FER A CHEVAL.—In fortification, a horseshoe, a small round or oval work, with a parapet, generally made in a ditch or in a marsh. It further means, according to the French acceptation of the term, a work constructed for the purpose of covering a gate, by having within it a guard-house, to prevent the town from being taken by surprise.

FERDWIT.—In the ancient military history, a term used to denote the freedom from serving upon any military expedition, or, according to some, the being acquitted of manslaughter committed in the army.

FERENTARII.—Among the Romans, the auxiliary troops lightly armed; their weapons being a sword, arrows, and a sling. We have also mention of another sort of Ferentarii, whose business was to carry arms after the army, and to be ready to supply the soldiers therewith in battle.

FERGUSON RIFLE.—A curious breech-loader used early in the Revolutionary War. Major Ferguson, a British officer, was authorized to arm and drill his troops according to his own ideas; and if tradition and circumstantial evidence are to be relied on, it was his purpose to place in their hands a *breech-loading rifle* with a variety of improvements, considered of recent date. Some of these rifles were used in the battle of King's Mountain, 7th October, 1780, the turning point of the war at the South,—as Oriskany, another riflemen's fight, 6th August, 1777, had been at the North,—a battle in which he was defeated and slain. Although a breech-loader not of American invention, it has become American from the fact that it made its first appearance as a weapon of war on the battle-fields of America, and is the first instance of a breech-loading rifle ever having been used on this Continent or any other. The arm has been photographed and engraved. Referring to the drawing, a few details will serve to explain its peculiarities. The length of the piece itself is 50 inches, weight 7½ pounds. The bayonet is 25 inches in length and 1¼ inch wide, and is what is commonly called a sword-blade bayonet; flat, lithe yet strong, of fine temper and capable of receiving a razor edge, and, when unfixed, as serviceable as the best balanced cut-and-thrust sword. The sight at the breech is so arranged that by elevating it is equally adapted to ranges varying from one hundred to five hundred yards. Its greatest curiosity is the arrangement for the loading at the breech. The guard-plate which protects the trigger is held in its position by a spring at the end nearest the butt. Released from this spring and thrown around by the front, so as to make a complete revolution, a plug descends from the barrel, leaving a cavity in the upper side of the barrel sufficient for the insertion of a ball and cartridge or loose charge. This plug is an accelerating-screw, and is furnished with twelve threads to the inch, thereby enabling it, by the one revolution, to open or close the orifice; so that the rifle is thereby rendered capable of being discharged, it has been claimed, as rapidly as Hall's United States (flintlock) carbine. This accelerating-screw constitutes the breech of the piece, only instead of being horizontal, as is usually the case, it is vertical. Were there not twelve independent threads to this screw, it would require two or three revolutions to close the orifice; whereas one suffices. Many of the muskets fabricated in the French arsenals during the last years of Napoleon had bayonets of the shape mentioned herein adapted to them, specimens of which were deposited among the French trophies in the Tower of London. In case of any injury to the fire-arm, the sword-blade bayonet would have been as effective a weapon as the artillery or even the infantry sword carried by foreign troops.

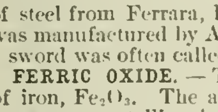
FERRARA.—A sword of excellent temper, made of steel from Ferrara, Italy. The kind most prized was manufactured by Andrea di Ferrara; hence such a sword was often called an Andrea-Ferrara.

FERRIC OXIDE.—The peroxide or sesquioxide of iron, Fe_2O_3. The anhydrous peroxide, as found in nature, crystallizes in flattened, rhomboidal tablets, nearly black and very brilliant, known to mineralogists as "specular iron;" it also occurs in compact red masses, called "red hematite." Prepared artificially, by calcining ferric protosulphate, or copperas, it is a red powder, called colcothar, used as a paint, and for polishing silver and mirrors. Magnetic iron-ore is commonly held to be a compound of ferric oxide and ferrous oxide, $Fe_2O_3 + FeO = Fe_3O_4$.

FESS.—The Fess in Heraldry consists of lines drawn horizontally across the shield, and containing the third part of it, between the honor point and the nombril. It is one of the honorable ordinaries, and is supposed to represent the waist-belt or girdle of honor, which was one of the insignia of knighthood.

PER FESS.—A shield, or charge in a shield, is said to be *party per fess* when it is horizontally divided through the middle, or, as the French say, simply *coupé*.

FESSWISE is said of a charge placed *in fess;* that is to say, horizontally across the shield. See *Heraldry*.


Fetlocks.

FETLOCK—FETTERLOCK. English heralds speak of a horse fetlock or horse fetterlock, and represent it as in the two accompanying figures. It seems to have been an instrument fixed on the leg of a horse when put to pasture, to prevent his running off. In Scotch Heraldry, a hoop is usually substituted for the chain, and the fetlock is represented as in the arms of Lokkert (Lockhart) of Barre, given by Sir David Lindsay: Argent, on a bend sable three fetterlocks *or*. Some branches of this family carry a man's heart within the fetterlock, one of the heads of it having accompanied good Sir James Douglas with King Robert the Bruce's heart to the city of Jerusalem.

FETTER.—To put fetters upon, or confine the feet with a chain. Deserters are frequently fettered while undergoing punishment for the crime of desertion.

FEUD.—Another form of the word *fight*, and is allied to *foe*, and probably to *fiend*. It meant a war waged by one family or small tribe on another, to avenge the death or other injury of one of its members. In a certain state of society this is a legitimate mode of obtaining redress. It prevailed extensively among the nations of Northern Europe; and it was only by gradual steps that the practice was first restricted and then abolished. The laws of Rudolf I. of Germany recognized the right of waging feuds. At last partial associations were formed, the members of which bound themselves mutually to settle their differences by Courts of Arbitration and Compensation, without going to war.

FEUDAL.—Consisting of, or founded upon, feuds or fiefs; embracing tenures by military system; as, the feudal system. By some, the word *feu* or *feud*, of which *feudal* is the adjective, is derived from the Latin *fides*, faith, and *ead* or *odh*, or *od*, a Teutonic word signifying a property, or estate, in land; whilst by others, with perhaps greater probability, the first syllable also is maintained to be Teutonic, equivalent to *rich*, cattle, ultimately from the same root with the Latin *pecus*, which, in the form of pecunia, came to signify property, and its representative, money—because, as Varro remarks, property amongst pastoral nations consisted of cattle.

FEU DE JOIE.—A discharge of musketry into the air, made in honor of a victory or other great occasion. It commences with the right-hand man of the line, who discharges his rifle, and is followed successively, at scarcely perceptible intervals, by the men on his left, until the extreme left of the line is reached. The effect much depends on the regularity with which the slight interval between the discharges is preserved.

FEU RASANT.—A grazing fire, or a discharge of musketry or cannon, so directed that the balls shall run parallel with the ground they fly over, within 3 or 4 feet of the surface.

FEVER.—In veterinary practice a disease characterized by increased heat, quick pulse, and thirst. In horses it is caused by cold or chill, high feeding, irritation, or pain. The symptoms are lassitude, shivering, quick pulse, and breathing after feed. The cure consists in bleeding, and keeping open the bowels by clysters and laxative medicine. The animal's body and extremities should be kept warm by clothing and hard rubbing; the diet green meat, or bran mashes, chilled water; and the horse should be kept as quiet as possible.

FEZ.—A red cap without a brim, commonly worn by the Turkish soldiers and others.

FICHANT.—In fortification, a term applied to flanking fire which impinges on the face it defends; that is, of a line of defense where the angle of defense is less than a right angle. A fortification is said to be *fichant* when the command is very great.

FID.—1. A block of wood used in heavy-gun exercise, for slinging the gun, and for mounting and dismounting purposes. The latest pattern of fid is of beech or elm, and each is provided with a rope grummet, and has the nature of the gun for which it is intended stamped upon it.—2. A large pointed pin for splicing ropes, with an eye at the thick end, of iron or lignum vitæ, used by sailors in separating and interlacing the strands of which the rope is composed.

FIEF.—An estate held of a superior on condition of military service; a fee; a feud.

FIELD.—1. A cleared space or plain where a battle is fought; also, the battle itself. *To take the field* means to commence active operations against the enemy.—2. In Heraldry, the field is the whole surface or continent of the escutcheon or shield. It is so called, according to some, because it represents the field of battle on which the achievements or charges represented on it are supposed to have been gained. In blazoning, the tincture or metal of the field must be the first thing mentioned.

FIELD-ALLOWANCE.—A daily allowance granted to officers of the British army in consideration of extra expense entailed upon them in consequence of military operations. *Ordinary* field-allowance, ranging from £1 10*s*. for a General Officer to 1*s*. for a Subaltern, is applicable when troops are encamped at home or in the Colonies. *Extraordinary* field-allowance is sanctioned when and wherever troops are engaged in actual warfare: it ranges for the above ranks from £2 10*s*. to 1*s*. 6*d*. Strict rules are laid down that no officer shall receive this allowance unless positively present with the army.

In India there is no such allowance, as the pay which officers receive is considered sufficient to enable them to keep up their camp equipage, and to meet all expenses attendant upon a move from cantonments or in setting out on a campaign. See *Allowances*.

FIELD AND MOUNTAIN AMMUNITION.—The ammunition for field and mountain service in the United States service consists of—*shot* for the 12-pounder gun; *shells* for the 12-pounder gun, 12-pounder mountain-howitzer, and 3- and 3½-inch rifle-guns; *case-shot* for the 12-pounder gun, 12-pounder mountain-howitzer, and 3- and 3½-inch rifle-guns; *canister* for the 12-pounder gun, 12-pounder mountain-howitzer, and 3- and 3½-inch rifle-guns. The projectiles are attached by straps of tin to a wooden sabot, to which is also fastened the *cartridge-bag* containing the charge for the 12-pounder and the mountain-howitzer, making together one round of fixed ammunition. With rifle-guns the cartridge is not attached to the projectile. The cartridge-bag is a cylindrical bag with a circular bottom, made of merino or serge. The material should be composed entirely of wool, free from any mixture of thread or cotton, and of sufficiently close texture to prevent the powder from sifting through; that which is twilled is preferred. Flannel is used when the other materials cannot be conveniently obtained.

The manner of fixing and strapping ammunition is explained in the articles Fixed Ammunition and Strapped Ammunition. The following is the mode of charging shells for field and mountain service: The shells having been properly cleaned, dried, tapped to receive the plug and the fuse, and attached to the sabot, are placed in two rows. The workman fills the measure with powder, strikes it level with the straight-edge, and pours it in the shell; the assistant holds the funnel, and marks the shell with chalk when filled, to prevent mistakes. The assistant screws in the plug. The workman puts a little white-lead on the threads of the fuse, punches 4 or 5 small holes in the tin disk, and screws the fuse firmly into the shell, the assistant holding the shell to prevent it from turning.

In the matter of a case-shot, the shot having been cleaned and inspected, the upper part of the fuse-hole is tapped to receive the fuse; the small hole is tapped to receive the plug. The following materials are required to fill the shells: spherical leaden balls, caliber .69 inch; sulphur or rosin; linseed-oil. To fill the shell, cover the lead balls with linseed-oil, and fill the shell with them, pushing the upper balls aside with a stick, to get in as many as possible. Warm the shell gently, and screw the neck of the funnel into the fuse-hole; pour in the melted sulphur, filling the shell. To make the chamber for the charge, chuck the shot in a lathe; screw the funnel into the fuse-hole to protect the threads from being injured by the auger, and with a common screw-auger bore a hole in the axis of the shell to the bottom. Diameter of the auger, .75 inch. Lacker the shot and strap it; paint it red. To charge the shot, fill the chamber with musket-powder, ramming it slightly with a wooden drift and light mallet; screw in the iron plug, leaving its top flush with the bottom of the large portion of the fuse-hole, and lay over it a thin leather washer with a hole in the center; fill the hole in the plug and washer with rifle-powder; punch four or five small holes in the tin disk in the bottom of the fuse; put a little white-lead on the threads of the fuse, and screw the fuse firmly into the shell. The case-shot is fixed the same as round shot.

A canister for field-service consists of a tin cylinder attached to a sabot, and filled with lead balls, eleven to the pound. Canister for the mountain-howitzer are filled with lead balls. The following materials are required: sheets of tin, .02 inch to .025 inch thick (double tin); soft solder; rosin; culots of rolled iron, .25 inch thick; covers of sheet-iron, .07 inch thick for the guns and 12-pounder howitzers, and .1 inch thick for the 24- and 32-pounder howitzers; sabots; tacks.

Canister for rifle-guns have metal sabots, and are filled with lead balls. The following utensils are required: patterns; tracing-point; shears; cylinder of hard wood; mallet; gauges; furnace; soldering-iron; hammer; punch. To make the cylinder, the workman marks out the rectangle on the sheet with the pattern, cuts it, and traces the line for the lap. He draws a line parallel to the long side of the rectangle, .4 to .5 inch from it, for the length of the slits. It is then bent round the former, the edge brought to the line of the lap, clamped and soldered. If lumps of solder be left, they are filed down. The cylinder is made round and gauged on the exterior with the large shot-gauge of the caliber, and the interior with a cylinder of a diameter .02 inch less than that given in the table, which should enter the canister. If it be not of the right size, it is unsoldered and soldered over again. The slits are made and the sabot inserted and nailed with 6 to 8 nails. Before filling the canister, dip the tin cylinder into a lacker of beeswax dissolved in spirits of turpentine, to prevent it from rusting. Coat the plates with paint or coal-tar.

The workman, sitting astride the bench, places the canister upright in front of him; inserts the iron bottom and places it flat on the sabot; puts in a tier of balls; fills the interstices with dry, sifted sawdust; packs it with a pointed stick, so that the balls will hold by themselves, and throws out the loose sawdust. He places another tier of balls, each ball lying in the interval between two balls of the lower tier, and proceeds in the same manner until the canister is filled; covers the upper tier with sawdust; puts on the cover, places on it one of the iron bottoms furnished with a handle, and strikes it with a small mallet in order to compress the sawdust; then removes this bottom, and turns down the slit pieces of the canister over the cover with a hammer. In the canister for the 12-pounder gun the center ball of the last tier is omitted. When the canister is finished, verify its diameter with the large shot-gauge of the same caliber.

The Sawyer canister-shot for all guns and howitzers consists of a casing of malleable iron, in one piece, in the form of a hollow cylinder, having one end closed by a head cast therewith, through which head is formed one or more small holes, through which a portion of the gas occasioned by the explosion of the charge of powder enters, driving forward the small iron balls, and disengaging the metal cover placed in the forward end of the casing to hold the contents in position till fired. The casing has, cut through its walls, one or more series of oblique slits, the end of each slit slightly overlapping the end of the next slit in the same series, thus nearly severing the casing into two or more sections, said sections being held together only by narrow bars of metal between the contiguous ends of two slits, which bars are sufficiently strong to withstand the ordinary shocks of handling and transportation, but not strong enough to resist the shock of the explosion of the charge of powder in the gun, so that when the shot is discharged from a gun the cover is stripped from the mouth of the casing, and the casing is broken into two or more sections, from which the small shot are more readily and completely discharged than they would be if the casing remained intact.

SUMMARY OF THE AMMUNITION FOR FIELD AND MOUNTAIN SERVICE.

		Smooth-bore gun.				Howitzer.			Rifle-guns.						Hotchkiss.	
		12-pounder, bronze.				12-pounder mountain-howitzer.			3-inch iron.			3.5-inch iron.			Revolving cannon.	
		Shell.	Case.	Shot.	Canister.	Shell.	Case.	Canister.	Shell.	Case.	Canister.	Shell.	Case.	Canister.	Shell.	Canister.
Charge of powder	pounds	2	2.5	2.5	2	0.5	0.5	0.5	1	1	1	2.25	2.25	2.25	*Grains.* 1,850	*Grains.* 1,850
Height of charge	inches	3.75	4.75	4.75	3.75	2.25	2.25	2.25	5.75	5.75	5.75	7	7	7	3.5	3.5
Cartridge-bag: Length	"	14.2	14.2	14.2	14.2	10.42	10.42	10.42	9	9	9	11	11	11	4.724	4.724
Cartridge-bag: Width	"	10	10	10	10	5	5	5	8.75	8.75	8.75	9.5	9.5	9.5	...	...
Cartridge-bag: Diameter of bottom	"	5.25	5.25	5.25	5.25	4	4	4	3.75	3.75	3.75	4.5	4.5	4.5	1.641	1.641
Sabot: Whole height	"	2.125	2.125	2.125	2.285	2.785	2.785	3.781	...	...	...	...	...	.5	...	...
Sabot: Height of cylinder	"	...	...	...	0.575	2	2	2.55	...	...	...	...	...	...	...	...
Sabot: Diameter of cylinder	"	4.45	4.45	4.45	4.45	4.4	4.4	4.4	...	...	...	...	...	...	...	...
Sabot: Diameter of top of cone	"	...	...	...	...	4.17	4.17	4.15	...	...	...	...	...	...	...	...
Sabot: Diameter of bottom of cone	"	...	...	...	...	3.175	3.175	3.23	...	...	...	...	...	...	...	...
Strap: Length	"	7	7	13	...	7	7	7	...	...	...	...	...	...	...	...
Strap: Width	"	0.5	0.5	0.5	...	0.5	0.5	0.5	...	...	...	...	...	...	...	...
Rings, diameter, exterior	"	3.25	3.25	...	...	3.25	3.25	3.25	...	...	...	...	...	...	...	...
Weight of sabot	ounces	4.5	4.5	4.5	7.5	5.5	5.5	9.5	...	...	...	...	...	...	...	...
Weight of projectiles, strapped (Shell and case loaded.)	pounds	8.8	11.25	12.1	14.2	9.35	12.2	11.2	8.12	9.13	...	...	...	...	...	...
Canister: Length	inches	...	...	...	14.35	...	...	14.4	...	...	8.0	...	...	11	...	...
Canister: Height	"	...	...	...	6.66	...	...	4	...	...	7	...	...	8.5	...	...
Canister: Interior diameter	"	...	...	...	4.45	...	...	4.47	...	...	2.8	...	...	3.2	...	...
Canister: Diameter of plates	"	...	...	...	4.38	...	...	4.42	...	...	2.8	...	...	3.2	...	...
Canister: Thickness of top plate	"	...	...	...	0.116	...	...	0.1	...	...	0.125	...	...	0.125	...	...
Canister: Thickness of bottom plate	"	...	...	...	0.125	...	...	0.125	...	...	0.125	...	...	0.125	...	...
Canister: Number of shot		...	...	...	27	...	...	148	...	...	154	...	...	0.140	...	...
Canister: Weight	pounds	...	...	...	14.2	...	...	14.2	...	...	10.75	...	...	17	...	...
Fixed ammunition: Whole length	inches	9.5	10.3	10.7	12.12	8.17	8.17	9.4	...	...	...	...	...	...	8.15	8.15
Fixed ammunition: Weight	pounds	11	13	15.3	16.44	9.0	12.6	11.8	...	...	...	...	...	...	*Lb. Ozs.* 1 10¼	*Lb. Ozs.* 1 9.4
Packing box: Interior diameter: Length	inches	17.5	17.5	17.5	18.37	27.5	27.5	27.5	16.5	16.5	16.5	11	11	11	...	...
Packing box: Interior diameter: Width	"	9.75	9.62	10.5	12.5	9.25	9.25	9.25	12.5	12.5	12.5	11	11	11	...	...
Packing box: Interior diameter: Height	"	9.25	9.25	9.5	9.5	8.5	8.5	9.5	8	8	7.5	9	9	8	...	...
Packing box: Weight, packed	pounds	106	122	140	156.5	154	184	175	161	184	175	160	180	198	...	...
Packing box: Number of rounds		8	8	8	8	12	12	12	12	12	12	9	9	9	...	...
Packing box: Number of primers		10	10	10	10	18	18	18	18	18	18	14	14	14	...	...
Packing box: Color		Black	Red	Olive	Drab	Black	Red	Drab	Black	Red	Drab	Black	Red	Drab	...	...

For the greater security of field-ammunition, the cartridges are covered with paper cylinders and caps. The cap is drawn off at the moment of loading the piece, and in using solid shot it may be placed over the shot to diminish the windage. A cylinder and a cap are formed together by folding the paper over a former, which allows a lap of about .75 inch for pasting. The requisite length for the cylinder is cut off from the smaller end. The rest forms the cap, which is choked at the end from which the cylinder is cut on a cylindrical former, which has a groove around it, marking the length from the rounded end for cutting the cap. The former should be bored through the axis with a .5-inch hole, to facilitate drawing off the cap. The caps for shells are black; for spherical case-shot, red; for shot, not colored.

On the preceding page will be found a summary of the ammunition for field and mountain service.

Shells are filled with the bursting-charge of mortar-powder to their capacity. Case-shot are filled with lead balls which are set with melted sulphur or rosin, and bored out for the bursting-charge with as large a chamber as the fuse-hole will admit of, which is filled with powder or bursting-charge of other explosive, space being left for the fuse-plug or fuses. When sabots are used, a spherical cavity is made for the seat of the projectile. When port-fires are used, one to each box of ammunition, and half a yard of slow-match is packed, and sufficient tow to render the whole packing secure. Large charge for 3-inch rifle-gun, 1.5 pound; half an inch is allowed for each seam in a cartridge-bag. Rifle-ammunition has no wooden sabots, nor is the cartridge attached to the projectile; these are packed on top of the projectiles, or, better, in a part of the box separated from the projectiles by a partition, in which case the small stores are packed on top of the cartridges. Hotchkiss ammunition is metallic; wrapped metal; centre-primed case. See *Ammunition*, *Ammunition-boxes*, *Cartridge-bags*, *Fixed Ammunition*, *Projectiles*, *Sabot*, and *Strapped Ammunition*.

FIELD-ARTILLERY.—Field-cannon are intended to be used in the operations of an army in the field; they should, therefore, have the essential quality of mobility. They are divided into light and heavy pieces. The former are constructed to follow the rapid movements of light troops and cavalry. The latter are employed to follow the movements of heavy troops, to commence an action at long distance, to defend field-works and important positions on the field of battle, etc.; hence they are said to constitute "batteries of position." Formerly the light pieces of the field-service of the United States were the 6-pdr. gun and 12-pdr. howitzer; and the heavy pieces were the 12-pdr. gun and 24-pdr. and 32-pdr. howitzers. At the commencement of the late war in this country, these pieces were set aside for arming field-works, block-houses, etc., and their places were supplied with the light 12-pdr. gun (smooth-bore) and the 3-inch rifle-gun. The regulations prescribe that, as a general rule, one third of the pieces of a field-battery be rifles and the remainder smooth-bores. Of course this proportion is subject to be modified by the character of the operations and the nature of the country. The country in which most of our late military operations were conducted was either broken in surface or heavily wooded, and the most effective fighting was done at moderate ranges, at which the light 12-pdr., with its heavy shell and case-shot, was found more destructive than the 3-inch rifle-gun.

Field-artillery is used in combination with infantry and cavalry, or with both, to augment their fire and to weaken that of the enemy. It prepares the way for subsequent operations by its fire upon the enemy before he comes within reach of other weapons; it supports the maneuvers of the various arms, and forms points of support and assembly for troops when driven back. In selecting the position for a battery, the ground must be considered both in plan and profile. The guns must be placed neither too high nor too low. Late wars have shown that it is not alone desirable but necessary to cover the guns and horses of a battery from the enemy's fire, either by the accidents of the ground or by improvised cover; for nothing else can insure the battery against destruction by the enemy's infantry and artillery. The range, accuracy, and rapidity of fire of small-arms of the present day are such that batteries which have been brought into action with the greatest possible rapidity have been placed *hors du combat* before firing a shot. The most favorable position is a gentle hillock, sloping gradually to the front and more abruptly to the rear, with a command over the ground occupied by the enemy of about 1 in 100. Considering the ground in plan, guns may be drawn up with good effect behind a marsh, pond, or river or ravine, provided such obstacles do not render an advance impracticable, and the ravine be not occupied by the enemy. The guns should not be in the neighborhood of woods, brush, or other cover that can be occupied by the enemy. Heavy, muddy ground, as well as that which is stony, should be avoided. The ground for 50 to 100 yards in front of the battery should be as unfavorable as possible for the enemy's artillery-fire.

The *extreme range* should be employed only when the nature of the ground or the shortness of the time does not permit a nearer approach to the object, and then only till the effect desired has been obtained. With rifled pieces this fire may exceed 5000 or 6000 yards. It may annoy troops in their camp, may impede the movement of trains, and endanger inflammable buildings and materials, but cannot affect an action; therefore, to open fire beyond the limit at which the effect can be ascertained by good sight, aided by telescopes, is a waste of valuable ammunition. If the ground and atmosphere be favorable, and the range can be determined accurately, fire may be opened against troops at 2500 yards, and under exceptional circumstances at 3000 yards; the former is about the distance at which bodies of troops can be distinguished with certainty by the best eye. This distance is modified by the formation of the troops; a column can be fired at effectively 500 yards beyond troops in line. At long range the object must be well defined, the distance carefully determined, and the firing calm and very deliberate. As a battery cannot withstand the fire of small-arms, artillery without cover cannot now maintain a position within 900 yards of the enemy's infantry.

The object selected upon which to direct the fire depends upon the nature of the action. In acting offensively, the fire should be concentrated on the enemy's artillery and on obstacles which oppose an advance; whilst if acting defensively, the guns should bear upon the infantry and cavalry. As a general principle, the fire should be directed upon that arm of the enemy which most immediately threatens us. Definite rules cannot be given for what must practically be decided almost entirely by the peculiar circumstances of the individual case. The nature and position of the object fired at determine the projectile to be used. The employment of solid shot is growing greatly into disuse; with rifled guns it is but little used, and in many services is entirely discarded, as the shell and shrapnel as now constructed are sufficiently strong and heavy to replace it and produce far more ultimate effect. It may be useful in firing over troops, but even then shells, preferably with percussion-fuse, can be employed. Shells are used at first to determine the range; for this, percussion-fuses are best if the nature of the ground permit. This fire is used to disable artillery; against columns of troops, or when a line can be enfiladed or taken obliquely; against obstacles, such as intrenchments and buildings, and against combustible materials. If the shell be intended for incendiary purposes, a time-fuse cut long is employed. Should the distance be accurately known and the time-fuse burn uniformly, such a fuse can be advantageously used; but generally a percussion-fuse is more useful. The nature of the ground is of importance only at the spot where the shell strikes; there it should be firm enough to cause a percussion-fuse to act and to prevent the shell from penetrating so far as to lose its explosive effect. Shell-fire is employed when the enemy is posted under cover, or on a higher or lower ground; when he is moving on a road through a valley, and when being pursued; when the ground is much broken, wooded, or cannot be seen; when the range is too great for effective shrapnel fire; for incendiary purposes, and when a moral rather than a physical effect is desired.

In the fire of shrapnel and segment shells, it is of more importance to have a knowledge of the distance than of the nature of the ground, as the elevation must be properly taken and the fuse correctly timed. If such a projectile explode after passing the object, its effect is entirely lost; and if it explode too far short, the effect is greatly diminished; therefore the aim should be taken a little short of the object, that it may be the more readily corrected. The spread of the pieces being greater in the direction of the fire than laterally, these projectiles are more effective against high, deep objects than against broad, flat ones; they are therefore more destructive against cavalry in column than in line, and more so against either than against infantry in column or in line. Shrapnel-fire is also employed against troops dispersed or scattered; against troops in defiles or openings, or massed at points. It is effective against artillery in position, especially when it can be taken obliquely; time-fuses should be used against the animate objects, and percussion-fuses against the *matériel*. Time- or percussion-fuses can be employed against troops in column or in line; but if they be scattered, time-fuses only should be used. Well-applied shrapnel-fire is more effective than any other artillery-fire against troops, but it is subject to so many contingencies, and the ammunition is so costly, that it should not be employed unless it will probably create considerable effect, and when other projectiles will not answer. The possibility of shrapnel exploding in the piece causes great care to be necessary in firing over the heads or through the intervals of the troops. The fire of canister-shot is confined to ranges within 500 yards, and is rarely of any effect beyond 350 yards. The nature of the surface has a great influence on the utility of this fire; it is largely diminished on rough or soft ground, especially if covered with bushes or standing crops, and is increased on hard, level ground. As batteries can no longer move up to short range of troops and open fire with canister, its use offensively is entirely ended. On the defense, it is used to most advantage against troops in column whose front is greater than thirty or forty feet; it is useful against scattered or dispersed troops at short ranges, and against the attack of field-intrenchments, villages, and the skirts of woods. In cases of great emergency, a double charge of canister, fired with a single cartridge, may be used for distances within two hundred yards. A canister-fire should not be used too early, as, if ineffective, it destroys the confidence of the troops and increases that of the enemy. It does not always produce the desired effect: 1st, because the distance is underestimated; 2d, sufficient care is not taken in aiming, because the danger is exaggerated; 3d, the character of the ground is not properly appreciated and projectiles are wasted. The fire of machine-guns, which can be used effectively at 1500 yards, may replace the employment of canister.

The selection of the most suitable kind of fire, whether direct or ricochet, depends upon the distance of the enemy, the conformation and nature of the intervening ground, the formation of the troops, so far as it can be judged, and the effect to be produced. Direct fire should be employed whenever the surface of the ground is uneven and the quality of the soil varied, or the soil soft and light. It is used in special cases: 1st. When the enemy is so situated as to conceal the depth of his formation. 2d. When he is about to pass a defile, and the head of the column only is seen, or when the depth of the column can be seen by being commanded or overlooked. 3d. In all sustained cannonades. 4th. If the enemy be on a mountain or in a valley. When the difference of level between the object and piece is not great, the character of the fire will be determined by the nature of the intervening ground. Ricochet-fire should never be used for a less distance than 1000 yards, even when the ground is favorable, as it is necessary that the projectile should make at least two or three rebounds in front of the enemy. For the 12-pounder gun the limits of this fire may be considered as between 1200 and 1500 yards; the extreme range extending, however, to 2000 yards: for a less distance the rebounds are too high and the space commanded too small. If the ground be uneven, ricochet-fire will be too irregular to be useful. An open, flat, and firm piece of ground is most favorable; if within a certain distance in front of the piece or of the enemy the ground be soft and uneven, this species of fire cannot be employed. As much depends upon chance in ricochet-fire, it is seldom used on the offensive, for it attracts the attention of the enemy without doing much execution. See *Artillery*, *Napoleon Gun*, *Ordnance*, and *Three-inch Rifle*.

FIELD-ARTILLERY FUSE.—The name given to the Breithaupt fuse by its inventor, because he designed it for all kinds of shells used with field artillery. See *Breithaupt Fuse*.

FIELD-BATTERY.—A certain number of pieces of artillery so equipped as to be available for attack or defense, and capable of accompanying cavalry or infantry in all their movements in the field. There are usually allotted to a field-battery four pieces in time of peace and six in time of war, and it is divided into *mounted artillery*, which usually serves with infantry, and *horse-artillery*, which ordinarily serves with cavalry. The main difference between the two consists in the cannoneers of the latter being mounted; in rapid evolutions of the former they are conveyed on the gun-carriages. See *Artillery* and *Battery*.

FIELD-BED.—A folding-bed used by officers while on campaigns or in the field. See *Camp-bedstead*.

FIELD-CARRIAGES.—A marked change has been made within the last few years in the fabrication of carriages for field and mountain artillery. The principal nations have arrived in quick succession at the same conclusion with reference to the material of which these carriages should be made, and have already abandoned the use of wood except for the spokes and felloes of the wheels, and for poles, and substituted in its place wrought-iron or steel. The consideration which has led to this important modification is the superior strength, serviceability, and ultimate economy of the wrought-iron carriage. The general plan of construction adopted is much the same in all countries, and the carriages differ only in minor details, which vary according to the different ideas of taste and convenience, or as influenced by long-established usage.

The cheek and side of the trail are formed of one piece of boiler-plate, cut into the required shape and strengthened by angle-iron riveted to it around its outer edge, or made in one piece in a die, with the flange struck up while the metal is hot. The two pieces constituting the trail are joined together by the necessary transom and bolts, and by the lunette, which is riveted to both. The trail is further strengthened by the transoms forming the two ends of the trail tool-chest. The two pieces which form the sides of the trail slope from the head of the cheeks or from a point a short distance in rear of it to the lunette, and at the same time diminish in depth. The angle-iron which is riveted to the cheeks to strengthen and stiffen them forms also the trunnion-beds, and is placed sometimes on the outside and sometimes on the inside of the plate. The elevating-screw is arranged differently in different services. Minor differences will be mentioned in describing the carriages in detail. The nomenclature is given in detail in the description of the carriages employed in the United States service.

United States.—There is a gun-carriage for the three-inch rifle, which with slight modifications is adapted to the one-inch mitrailleur; one for the half-inch mitrailleur; and one for the twelve-pounder. The corresponding parts of these carriages differ only in their dimensions. There are three kinds of wheels, viz.: No. 1, for the three-inch rifle and one-inch mitrailleur gun-carriages, for caissons, forges, battery-wagons, and all limbers except those of the half-inch mitrailleur; No. 2, for the twelve-pounder gun-carriages; No. 3, for the half-inch mitrailleur gun-carriages, caissons, and limbers. Wheels Nos. 1 and 2 are of the same form and height, fit on the same axle-arm, and differ only in the dimensions of their parts, strength, and weight. It is proposed that a single pattern of wheel be used hereafter for all light artillery-carriages except those for the half-inch mitrailleur.

Referring to Fig. 1, the nomenclature of the gun-

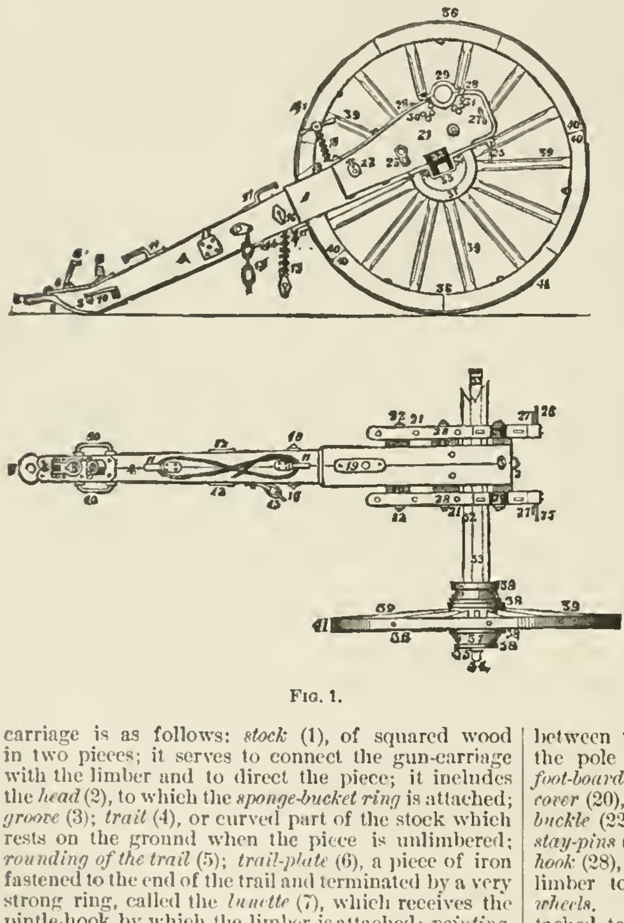


Fig. 1.

carriage is as follows: *stock* (1), of squared wood in two pieces; it serves to connect the gun-carriage with the limber and to direct the piece; it includes the *head* (2), to which the *sponge-bucket ring* is attached; *groove* (3); *trail* (4), or curved part of the stock which rests on the ground when the piece is unlimbered; *rounding of the trail* (5); *trail-plate* (6), a piece of iron fastened to the end of the trail and terminated by a very strong ring, called the *lunette* (7), which receives the pintle-hook by which the limber is attached; *pointing-rings*, large (8) and small (9), which receive the handspike; *trail-handles* (10), on each side of the stock for the purpose of raising it; *prolonge-hooks* (11), on which the prolonge is coiled; *wheel-guard plates* (12). *Lock-chain* (13), used to keep the wheel from turning; it is on the side of the carriage, and has an *eye-plate* and *bolt; sponge-and-rammer stop* (14); *sponge-chain* and *hasp* (15); *ear-plate* for sponge-chain and hasp (16); *ear-plate* to support worm (17); *key-chain* and *key; elevating-screw* (18); it has a *handle* with four prongs; *elevating-screw box; elevating-screw bed* (19); *rondelles* (20), which connect cheeks and stock; *cheeks* (21), two pieces of wood between which the gun rests; *washer-hooks* for handspike (22); *washer-hook* for lock-chain (23); *under-strap* (24); *right sponge-hook* (25); *sponge and worm hook* (26); *handspike-rings* (27); *trunnion-plates* (28), into the *beds*, or depressions, of which the trunnions fit; *cap-squares* (29); *cap-square chain* (30); *key-chain* and *key* (31). *Axle*, including *axle-body* (32), of wood; *axletree* (33), of iron; *axle-arm* (34), the rounded extremities of the axletree on which the wheels revolve; *linch-pin* (35); *linch-pin washer* and *hook*. *Wheels* (36); each includes—*nave* (37); *nave-bands* (38); *nave-box; spokes* (39); *felloes* (40); *tire* (41). *Cannoneers' seats*, on the axle between the cheeks and wheels; each consists of an iron *chair* supported on a *rectangular bar* inserted in a vertical iron *socket*, and resting on a strong steel *spring;* the socket is supported by two *brass braces* fastened to the axle by *axle-straps;* to an iron *cross-piece* at the top of the socket are attached two *iron braces* which help to support the iron *foot-rest* attached to the brass braces. The chair has *arms* and faces to the trail.

The following is the nomenclature of the gun-carriage for mitrailleurs: *stock; head; groove; trail; rounding of trail; trail-plate; lunette; pointing-ring; pointing-socket; trail-handles; wheel-guard plate; elevating-screw; elevating-screw box; elevating-screw bed; rondelles; cheeks; washer-hooks* for handspike; *under-straps; handspike-rings; cap-squares; cap-square chains; key-chains* and *keys; trunnion-beds; trunnion-swivel; trunnion-swivel friction-bed; frame for traversing-apparatus,* or *traversing-arm; traversing-fork; traversing-fork spring* (spiral); *traversing-fork handle; traversing-fork clamp-screw; traversing-fork case,* with slot for handle; *locking-bolt,* connected with traversing-fork by a *locking-lever; locking-bolt case; stock-seat;* with a *hinge* and *prop; drag-hooks; elevating-screw nut; elevating-nut handle; elevating-clamp screw; rod-case* and *keys; axle; wheels.*

All limbers (Fig. 2) are similar; the limber-chests of gun-carriages and caissons contain ammunition and implements; those of forges and battery-wagons contain tools and stores. The nomenclature is as follows: *pole* (1), including *pole-pad* (2); *pole-straps* (3), by which the pole is guided when the team is hitched; *pole-strap iron* (4); *pole-yoke* (5); *muff and collar* (6); *pole-yoke branches* (7), to which are attached *sliding-rings* (8); *splinter-bar* (9), to which the wheel-horses are hitched, by four *trace-hooks* (10); *end-bands* (11); *middle-bands; pole-prop* (12), including *socket, ferrule,* and *chain; hounds* (13), the pieces of wood, upon which the chests rest, connecting the axle-body with the splinter-bar; *forks* (14), pieces of wood, between the hounds, forming an opening in which the pole is placed; *fork-strap* (15); *foot-boards* (16); *foot-board brackets* (17); *chest* (18); *chest-handles* (19); *cover* (20), of wood; *cover-plate* (21), of copper; *turn-buckle* (22); *hasp* (23); *back-stay* (24); *front-stay* (25); *stay-pins* (26); *stay-pin keys* (27); *under-strap; pintle-hook* (28), on rear part of axletree, which attaches the limber to the carriage; *pintle-hook key* (29); *axle; wheels.* The four trace-hooks are sometimes attached to the ends of the *splinter-bar traces,* which are strong leather straps, parallel to the splinter-bar; each works over two *pulleys,* attached to the end and middle bands; the pulleys are wrought-iron disks, turning on vertical bolts, passing through the rounded ends of the bands, which project three inches beyond the splinter-bar.

All caissons have the same external form, and, except those for the ½-inch mitrailleur, the same dimensions. The caisson *body* (Fig. 3) consists of a frame, mounted on wheels, which carries two chests, a spare wheel, and other spare parts, tools, etc. The nomenclature of the caisson body is as follows: *stock* (1), or *middle-rail;* it has an iron *lunette* on its front end; *side-rails* (2); *front foot-board* (3); *rear foot-board* (4); *middle-chest* (5); *rear-chest* (6); *spare-wheel axle* (7); it has a *body*, two *ribs*, and *chain and toggle* (8) to secure the wheel; there are also two *stays* for the axle; *lock-chains* (9), fastened to *lock-chain bridles* under the front ends of the side-rails, and held up by *lock-chain hooks* fastened to the outside of the side-rails; *spare pole* (10); *spare-pole key, key-plate, chain* and *pin* (11); the key-plate is fastened on the underside of the lunette; the key is attached to the left side of the stock by a *chain* and *eye-pin; carriage-hook* (12), for attaching a carriage that has lost its limber; *wheel-guard plates* (13); *spare-pole ring* (14), held by the axle-strap; *ring-bolt* (15) for spare handspike; *key-plate* and *key*, on the right side of the middle-rail; *key-plate, chain*, and *key* (16), for the shovel-handle, or the inside of the right side-rail; *middle assembling-bar* (17), of iron; it has two ears in the middle to serve as stay-plates for the middle chests, and a *slot* (18) for the axe on the right of the middle-rail; *rear assembling-bar* (19); it supports the spare-wheel axle, and has a *slot* (20) for the pickaxe on the left of the middle-rail. *Axle*, the *axle-body* (21) being notched to receive the middle rail and tenoned to fit into the notches in the side-rails; *staples* for *tool-handles* (22); they are driven into the top of the axle-body, in front of the iron axletree, one for the *shovel-handle* near the right side-rail, the other for the *handle of the pickaxe* on the left of the middle-rail. *Wheels.*

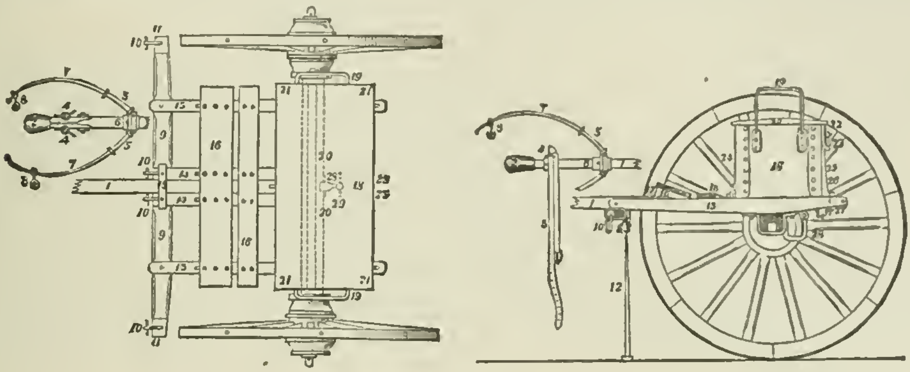


FIG. 2.

The Ordnance Department has recently made and tested certain wrought-iron field and siege carriages. The principal improvements aimed at in one of the patterns of field-carriages on the wooden carriages now in use are: 1. Lightness and cheapness. 2. Placing the pintle about two feet in rear of the limber axletree, so that the trail of the gun-carriage shall counterpoise the weight of the pole, and thereby relieve the shoulders of the wheel-horses which have now to support it. 3. Bringing the trunnion-beds nearer to the axletree, thereby diminishing the liability of overturning the carriage in traveling. 4. Allowing no part of the carriage to project below the plane of the axletrees. This is found necessary to prevent the breaking of the implement-fastenings in passing over stumps, stones, etc. 5. More convenient modes of carrying the rammers and trail handspike. 6. As the 12 pdr. carriage can be made of wrought-iron, so as to be little if any heavier than the wooden carriage used for mounting the 3-inch rifle-gun, but one carriage will be required for the field-service. In this case thimbles or washers will be required to fit the trunnions of the 3-inch gun into the trunnion-beds of the 12-pdr. carriage.

The very large stock of wooden carriages now on hand may delay, on the score of economy, the introduction of wrought-iron carriages for some time to come; but that such carriages can be made superior to wooden ones scarcely admits of doubt.

Austria.—The 3.42-inch gun-carriage (Fig. 4) is composed of two cheeks of sheet-steel .24 inch thick, re-enforced around the edge by an angle-iron .275 inch thick, the flange turned inward. The cheek-plates are parallel for a short distance in rear of the axle; from that point they converge to the end of the trail, where they are secured to the lunette. The cheek-plates are joined by two sheet-iron transoms toward the front end, and between them a cylindrical transom under the trunnion-beds; near the middle is a sheet-iron transom forming one end of the tool-chest; and the bolts passing through the principal irons. In order that the piece may not be too low, and to assure its having a sufficiently wide field of fire, the trunnion-beds have been raised considerably above the axle, and carried well forward.

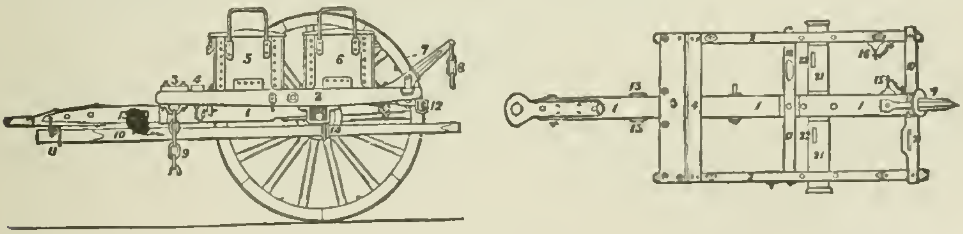


FIG. 3.

The axle is cylindrical, of steel, with shoulders for the cheeks, to which it is secured by solid bands and understraps. It is provided with two seats, like the Prussian carriage, and is braced to the trail by two rods just inside of the shoulder-washer.

The elevating-screw is composed of two screws, one within the other. The outer one, which works in a fixed nut between the cheeks, has a rim-handle for turning it. The head of the inner screw is hinged to two iron rods secured to the cheeks. The trail-handspike is secured to the socket, which is hinged to the support, so that the handspike can be turned down on the trail when it has been disengaged from the pointing-ring. The wheels have metallic naves, and are smaller than those in the United States service; they are only 52.75 inches in diameter. Two shoes are used for locking the wheel, and for checking the recoil in firing.

The limber is composed of two trough-beams, 3.5 inches by 2 inches by .2 inch, secured directly to the axle by understraps, and bent at the front so as to form the fork; a transom and a socket for the pole joins them in front; they are connected in rear by an iron bar placed on top, which supports the end of a double T-piece of iron, 2.75 inches by 2.36 inches, the web 1.57 inch; this piece carries the pintle-hook. The splinter-bar is round, hollow, fastened under the fork by understraps, and secured to the axle by iron rods. The distance of the pintle-hook from the axle is considerably greater than is necessary to balance the pole, it would seem, and increases the weight of the limber. The pole is of wood, and can be readily taken out or put in place.

The ammunition-chests are of sheet-steel .34 inch thick, and are divided by a principal vertical partition into two parts. Each part is in turn divided into six compartments by sheets of iron joined together, and strengthened by angle-irons at their junctions. The projectiles are packed in light wooden boxes, with cleats to keep them in place; the cover is held closed by a simple hook, and a handle is secured to it for withdrawing the box. The cartridges are placed in the compartments without doors. The chests are closed by two doors, which swing down around horizontal hinges placed on the lower edge of the chest; they are secured by means of a double turn-buckle attached to the principal partition, and by hooks near the ends of the chest. The handles of the chest are joined by a leather strap, and the rear part of the cover has a network for holding knapsacks. Three cannoneers can be seated on the front part of the chest. The limber-chest carries 34 rounds, of which 10 are shrapnel and 4 canisters.

The construction of the caisson is similar to that of the limber. It is composed essentially of a stock formed of two channel-beams 3.5 inches high and .2 inch thick, and two side-rails, also channel-beams, 2.75 inches high and .2 inch thick, bent in front to meet the stock, and joined at the rear by an iron bar. The caisson is provided with a brake, the cross-piece of which is a piece of round pipe suspended by a hinge from the side-rails. The spare wheel is carried under the caisson in a horizontal position. The spare wheel-axle is attached to the stock by a hinge a little in front of the axle of the rear wheels; the wheel is lashed to the body of the caisson.

The ammunition-chest is constructed like that of the limber, but has double the capacity. It is made, we may say, like two limber-chests, placed one in rear of the other, and is closed by 4 doors, 2 in front and 2 in rear, opening around the lower horizontal edge of the chest. It contains 60 projectiles, 35 of which are double shells, 20 shrapnel, and 5 incendiary shells, with 64 cartridges of 3.3 pounds, and 32 cartridges of 1 pound for plunging fire. The cover of the chest is provided with a netting for carrying various articles. The advantages which result from this mode of construction of the chest and the arrangement of the doors are so obvious as to make it needless to point them out.

The weights of the parts are as follows:

	Pounds.
Carriage with the gun and implements	2,264
Limber, packed	1,990
Caisson, packed	2,740
Gun with limber	4,255
Caisson, complete	4,731

England.—The cheeks are made each of a frame of angle-iron of the required form, re-enforced by welding to it at the place where the trunnion-bed should come a solid piece of iron of a thickness equal to the width of the angle-irons, and large enough to cut out of it the semicircular recess for the trunnion-bed, which is accomplished by means of a common band-saw. To the inner side of this frame a plate of boiler-iron of corresponding form is riveted. The cheeks are joined by two iron-plate transoms, one in front and the other in rear of the axle-body, by two bolts passing through iron pipes, and by the lunette. The cap-squares are secured by a chin-bolt which does not pass entirely through the cap-squares, and a pin which runs through the cheek and a hole in a lug welded to the under side of the cap-squares.

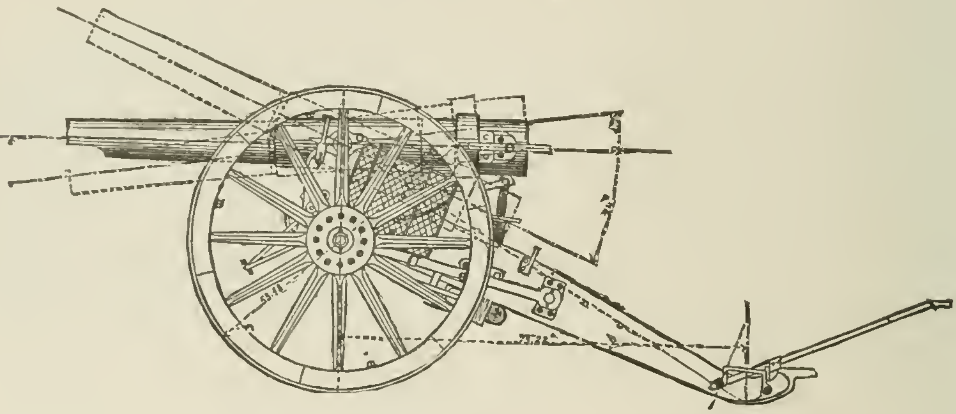


Fig. 4.

The elevating-apparatus (Fig. 5), which is known as the Whitworth pattern, consists of a long screw and bronze female screw with a bevel-gear cut on its lower surface. A spindle with a bevel-wheel on one end passes through the right cheek-piece, and has attached to it a bronze hand-wheel by which the screw is worked. The female screw and bevel-wheel are contained in a wrought iron box having trunnions which support it between the sides of the trail; the journal-boxes are bolted on the inside of the trail-pieces. The elevating-screw admits of elevations of 21° and depressions of 4°. The 16-pounder gun-carriage has a trail-box of sheet-iron, divided into two compartments, for holding the small tools. Its cover is fastened by a hasp and turn-buckle. The axle and axle-body are of iron, and constitute a beam, in section a box-girder. The body is riveted to the axle, and also to the cheeks, by means of angle-irons.

Two wooden boxes, strengthened by corner-irons and provided with iron handles, are secured to the axle-body, one on each side of the gun, and carry each two rounds of canister. They also serve as seats for two gunners. A step for their feet is fastened to the box, and when not in use slides out of the way. A lock-shoe is used to check the motion of the carriage down hill, and the chain is arranged so as to allow the wheel, when it is desired to unlock it, to run over the shoe, which is then picked up and hung on the carriage.

The wheels have bronze naves, which are in three pieces, the pipe-box being of harder metal than the two flanges. The felloes, of ash, and the spokes, of oak, are made by machinery. The inner ends of the spokes are wedge-shaped, and form when driven a perfect arch around the pipe-box. The tenons are not of the same diameter throughout their length, but are larger at the shoulder, and fit into the felloes bored with two bits of different sizes.

The limber is formed of three futchells, an angle-stay, a splinter-bar, and two stays, an axle, axle-body, and pintle hooks, all of iron, with foot-boards and shafts of wood. To diminish the weight thrown on the shaft-horse, the ammunition-chests are thrown well to the rear, and held by four knees of T-iron screwed to the rear side of the axle-bed. The limber is fitted for single, double, and treble draught, and for oxen. Three chests are carried on the limber. Two of them are similar. They are all made of wood, strengthened by corner-pieces of iron. The side chests are partitioned off to carry 18 rounds of ammunition. The center chest has copper partitions, and carries fuses, friction-primers, etc.

The caisson is of iron, with the exception of the foot-boards. The stock is formed of two channel-beams. The spare wheel is carried on an arm secured to two plates riveted to the inner sides of the beams forming the stock, the plates being bolted together with bolts having pipes over them between the plates. A block of elm to act as a stay is riveted to the stock. The caisson-body carries four ammunition-chests and four under-boxes. The ammunition-chests are the same as the side chests on the limber, except in some of the leather fittings. A lock-shoe is used, the same as for the gun.

The principal weights are as follows:

	9-pounder.	16-pounder.
Weight of gun-carriage, empty.........	1,300 lbs.	1,480 lbs.
Weight of gun-carriage, packed	2,320 lbs.	2,957 lbs.
Weight on pintle-hook, without gunners.	140 lbs.	147 lbs.
Weight of limber, empty..................	1,235 lbs.	1,270 lbs.
Weight of limber, packed................	1,731 lbs.	1,792 lbs.
Weight of caisson, empty................	2,725 lbs.	—— lbs.
Weight of caisson, packed..............	4,530 lbs.	4,660 lbs.

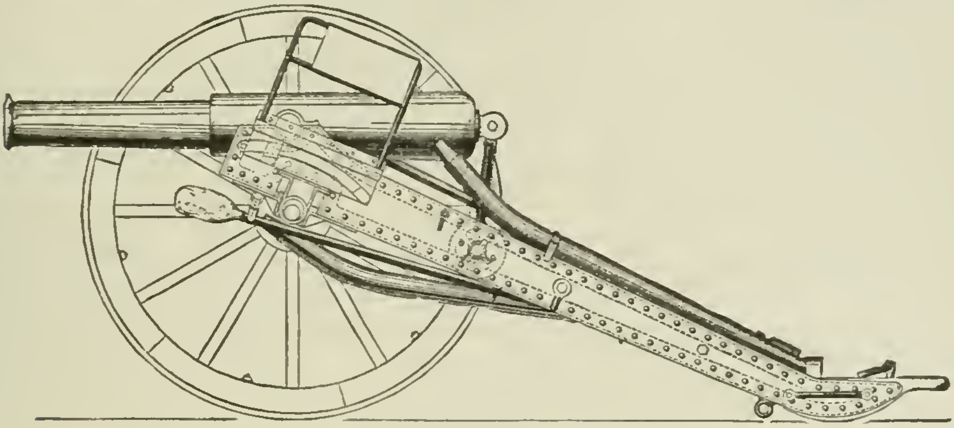


FIG. 5.

Germany.—The field-carriages are provided mainly by contract. Krupp makes the largest number. In his last model (Fig. 6) the cheek and trail-piece, instead of being strengthened by angle-iron riveted around the outer edge, is made of steel, and has this flange set up in a die while the metal is hot. The plates are first rolled to about the size required, then cut to the exact shape, heated to redness, and forced by means of hydraulic power into the die or former, which gives them the required form; that is, about 1½ inch of the edge of the plate all around is turned up like an angle-iron. This necessitates the provision of an expensive former, but when it has been once prepared the expense of making the cheek pieces is much diminished, while their weight for a given strength is considerably less than when the flange is riveted on. The cheeks are united by two plate transoms; that near the head of the cheeks is cut out so as to allow the gun to be depressed. The trail is further strengthened by the two ends of the trail-chest and the cover, which extends from the elevating-screw to the lunette, and by the different assembling-bolts. Each cheek is re-enforced by a system of braces secured to the inner faces between the flanges, and intended to prevent the trail from bending in firing.

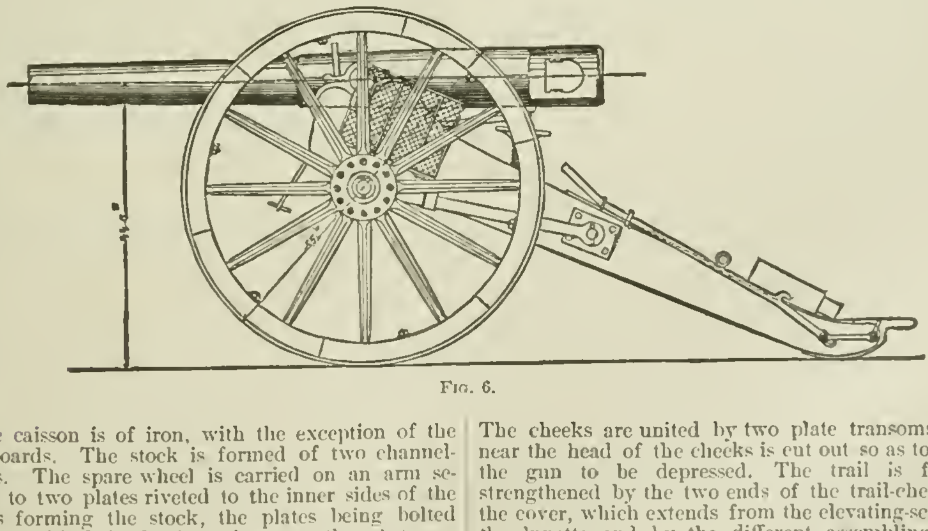


FIG. 6.

The axle is of tempered steel, and is cylindrical in the body. The arms are conical, and for a distance are flattened to hold the grease. The linch-pin is elliptical, and has a flat head, which may be used as a step. The wheels have bronze naves, twelve spokes and six felloes, of wood; their diameter is 55 inches (4 inches less than the model of 1864). The linch-washer is covered by a molding of the nave. Leather shoulder-washers are used to lessen the noise in marching. Two iron connecting-rods join the axles near the shoulder with the trail, strengthening the former. In the 9-centimeter these rods carry two seats for two gunners. The seats are provided with a back of netting, India-rubber springs to lessen the force of the shock going over rough roads, and a step for the convenience of the gunners taking their seats and to rest their feet on during the march. The carriage is provided with brakes, which are operated during the march by the gunners mounted on the axle-seats. The figure shows how these brakes are arranged; they may be also used to check the recoil in firing.

The elevating apparatus is composed of a double screw, the inner one having a flat head with a hole drilled in it. The breech rests on a bronze block, which is embraced by the two rod-supports; they turn around a horizontal bolt passing through the cheeks near the head of the carriage. The head of the inner screw is hinged to the rods under the block. The outer screw has a wheel-handle for giving the elevation. A small chain attached to the trail chest cover is used to place this wheel in its position, and

faces the gunner who is distributing the ammunition) has two rectangular openings, each provided with a door, which opens by turning down toward the rear. The doors are closed by means of hasps turning around the edge of the cover. An iron arc with two support-notches is attached to the right end of the cover and serves to hold it open.

Experimental caissons made of iron are now being tested with a view to their adoption.

The principal weights, in pounds, are as follows:

	3.1-in.	3.164-in.
Weight of the carriage with trail-handspike	1,080	1,157
Weight of the carriage with gun and implements	1,967	2,164
Weight of the trail on the ground..............	165	163
Weight of the limber not loaded	1,153	1,157
Weight of the ammunition	562	648
Weight of the tools, implements, etc............	253	253
Weight of the gun and carriage and limber without gunners	3,968	4,277
Weight for each horse without gunners..........	660	712
Weight of the caisson loaded for the batteries..	4,696	4,940

Russia.—This carriage is in its general construction like those already described. The cheeks are made of boiler-plate, .25 inch thick, and strengthened by angle-irons riveted around the edge. The axle is square in cross-section, 3 inches, and is strengthened to resist the recoil of the gun by a flat bar of iron bolted to it, the bolts not passing through the axle, but around it, and secured by nuts.

The wheels have bronze naves. Each felloe is bolted to the tire by a bolt near each end. Under the heads of each pair of bolts nearest each other is an iron plate, let into the under side of the felloe, and

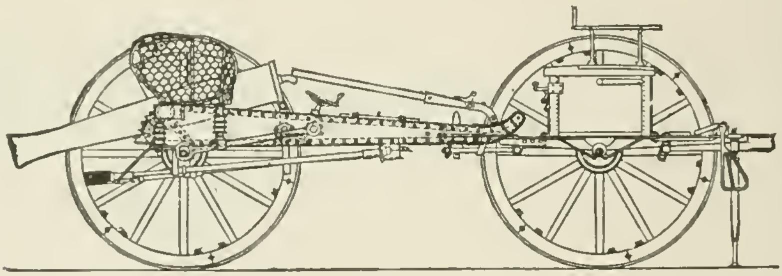


FIG. 7.

prevent it from turning during the march. The nut of the elevating-screw has trunnions which turn in trunnion-holes in the cheeks. The 8-centimeter gun-carriage will admit of elevations from 15° depression to 18° of elevation, and the 9-centimeter carriage from 15° depression to 16° of elevation.

Among the other irons of the carriage may be mentioned the trunnion-beds and cap-squares. These last are held in place by a vertical bolt, which passes through the flange, and serves as a handle for the man seated on the axle. The iron pointing-bar on the left cheek is movable around one of the lunette-bolts; it can be turned down to the rear, and rests on an iron fork on the cheeks. A case for grapeshot, with leather and felt lining, is on the left cheek, and on the right a sponge-ring near the axle-seat, and a sponge-socket near the lunette. A short rammer is transported in the trail-chest. It is composed of a wooden head and a hollow iron staff. It is used in placing the projectile and cartridge in position; the staff has a mark on it for this purpose. The staff may be also used to open the breech when it sticks; it is engaged in the handle as a key.

The wheels and axles of the limber are the same as for the carriage. Two parallel hounds embrace the pole at their front end, and are joined at the rear by a transom, to which the pintle-hook is fastened. The latest pattern is made of iron, with the exception of the wheels and pole.

The ammunition-chest is of sheet-iron, and has on it two iron supports for a leather back-strap for the gunners. The rear side (that is to say, that which

serving as a washer to the bolt-heads, thus strengthening the wheel at the junction of the felloes.

The elevating-screw is a double one, and allows of an elevation of 20°. The carriages made ten years ago were constructed with a top-carriage, which had a lateral motion around a vertical pintle fastened to the axle of the carriage. By this means the gunner could point the gun without depending upon the man at the trail-handspike to give it the exact direction. Experience showed, however, that the complication of the parts and the weakening of the carriage were not compensated for by the advantages gained, and this feature has been suppressed in the carriages of recent construction. The trail-handspike is of wood, shod with iron, and made fast to a hinge on the trail of the carriage, so that it can be, when not in use, folded back on the trail.

The ammunition-cart is covered with sheet-iron, and lined on the inside with coarse tow-cloth, glued to the wood. More recently the cart has been superseded by the caisson with four wheels, drawn by horses attached for draught as in our service.

Among the regular stores assigned to each battery is a brass mold for casting new jackets on projectiles which have been fired and recovered. The Khivan campaign developed serious objections to the leaden coat, some of the pieces having been rendered temporarily unserviceable by the leading of the bore. To prevent this in future, the lead-coated projectiles are covered with a composition made of 25 parts of beef-tallow, 50 parts of common soap, and 25 parts of paraffine, applied with a brush. New projectiles are provided with copper bands for filling the grooves and imparting rotation.

Instead of woolen sponges for sponging the bore, brushes are used; the bristles are held in place by pitch. Brass-wire brushes have been tried, but their use has been abandoned

The principal weights are as follows:

Gun, carriage, and limber, loaded, pioneers' tools and men's knapsacks included:	4,332 pounds for the 9-pounder. 3,660 pounds for the 4-pounder. 3,430 pounds for horse-artillery.
Weight for each horse, including five cannoneers, mounted on the carriage and limber:	720 pounds for the 9-pounder. 600 pounds for the 4-pounder. 550 pounds for horse-artillery.

France.—The French field-carriages resemble much the latest pattern of Krupp's carriage, in which the cheek-piece and flange are one piece.

Sweden.—The Swedish carriage (Fig. 7) is made of boiler-plate a little less than ¼ inch thick, strengthened by angle-iron, both on the top and bottom edges, the angle-iron being turned inward.

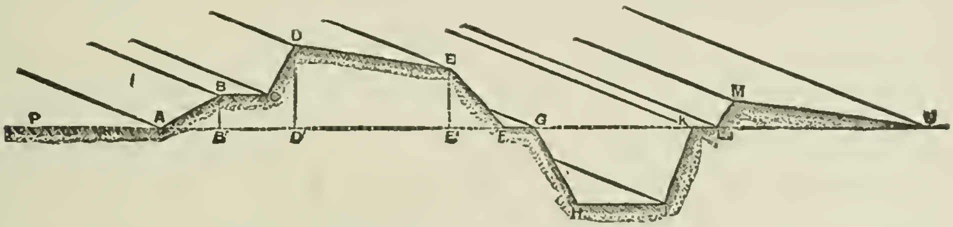
The elevating-screw is operated by means of a second screw, which turns the female screw of the former, thus raising or lowering the elevating-screw.

The limber has the pintle some distance in rear of the axle, thus serving to balance the pole and relieve the weight from the horses' necks.

The hounds are made of two pieces of angle-iron riveted together. See *Englehardt Gun-carriage.*

of the assailant should be swept not only by the front but the cross-fire of the assailed. 5. It should offer no obstructions to the free movements of the assailed either for the offensive or defensive, and afford facilities for active offensive movements at the opportune moment. 6. It should have secure natural points of support both on its flanks and in the rear. 7. It should afford every convenience for encamping and supplying the army. 8. Its lines of retreat should be ample and secure. As natural defensive positions, offering all or even the most essential of these advantages, are seldom met with, their defects have to be remedied by artificial means. These means from their object have received the name of *fortification*, which may therefore be defined as *the art of so arranging a position selected for defense that an inferior force shall be able to resist with advantage the assaults of one superior to it.* If the artificial means are of a durable character, and the position is to be permanently occupied, the works receive the name of *permanent fortification;* but when the position is to be occupied only for a short period, or during the operations of a campaign, perishable materials, as earth and wood, are mostly used, and the works are denominated *temporary* or *field-fortification.*

Fortifications should be regarded only as an accessory defensive means, but still a very important one, and they will conduce to the end proposed the more



Profile of Parapet and Ditch of Ordinary Field-fortification.

A B C D E F the profile of Parapet.
G H I K, is the profile of the Ditch.
L M N, the profile of the Glacis.
A B is the Banquette Slope.
B C, the Tread of Banquette.
C D, the Interior Slope.
D E, the Superior Slope.
E F, the Exterior Slope.
F G, the Berm.
G H, the Scarp.
H I, the Bottom of the Ditch.
I K, the Counterscarp.
A, the Foot of the Banquette Slope.
B, the Crest of the Banquette.
C, the Foot of the Interior Slope.
D, the Interior Crest.
E, the Exterior Crest.
F, the Foot of the Exterior Slope.
G, the Crest of the Scarp.
H, the Foot of the Scarp.
I, the Foot of the Counterscarp.
K, the Crest of the Counterscarp.
M, the Crest of the Glacis.
N, the Foot of the Glacis.

FIELD-COLORS.—Small flags, about 1½ foot square, carried along with troops for marking out the ground for the squadrons and battalions; camp-colors.

FIELD-DAY.—A term employed when a regiment is taken out to the field for the purpose of being instructed in the field-exercise and evolutions.

FIELDED.—A term formerly used to imply *in the field of battle*, or *encamped.* The word is now obsolete.

FIELD-FORTIFICATION.—When an armed force is constrained to act on the defensive, either from inferiority in numerical strength or discipline to its adversary, it should endeavor to counterbalance this disparity against it by selecting a position on which to receive battle, which will afford every military advantage to itself, and prove, in a corresponding degree, unfavorable to the assailant. A defensive position to afford these advantages should satisfy the following conditions: 1. It should present natural obstructions to the advance of the assailed, so as to deprive him of the advantage which his superiority in numbers or discipline would give him in a hand-to-hand conflict. 2. The features of the ground should screen the assailed from the assailant's view, and offer covers from the assailant's fire, whilst their own fire can be used with full effect. 3. It should command or overlook the ground over which the assailant will be obliged to advance, in such a manner that its surface will be swept by the fire of the assailed. 4. In like manner all the lines of approach

nearly they are made to satisfy the foregoing conditions of a strong defensive position. To satisfy the first three of these conditions—viz., to offer an obstruction to a hand-to-hand conflict; to shelter the assailed from the view and fire of the assailant; and to afford the assailed a commanding view and a sweeping fire over the assailant's lines of approach, fortifications must consist of a covering mass of earth, stone, wood, or iron of sufficient height and thickness to screen the men behind it from view, and to intercept the missiles of the assailed, and of some obstruction in advance of it which will prove a serious obstacle in the way of the assailant's advance.

The covering mass is termed a *parapet* when it fulfills the last two of these conditions; when intended simply as a screen, as in the case of a cover for cavalry when waiting to be brought into action, it is termed an *epaulement;* and when used to cover troops from an enfilading fire on the flank or in the rear, a *traverse.*

The most usual obstruction to impede the enemy's advance to attack with the bayonet is a *ditch* placed in front of the parapet. When the parapet is of earth, the ditch furnishes the material for its construction. The drawing shows the form and relative dimensions of the profile of the parapet and ditch of an ordinary field-fortification. When the top surface of the platform, termed the *banquette tread* is too high to be reached from the ground by an ordinary step, a ramp, either of earth or timber, is placed in the rear of it, by which it is reached. This ramp is called the *banquette slope*. The interior face of the parapet, when arranged for musketry, is termed the *breast-height* or *interior slope*; when for artillery, the *genouillère*. The top of the parapet is the *superior slope*. The exterior face is termed the *exterior slope*. Between the parapet and ditch a narrow zone is usually left on the natural surface of the ground, which is termed the *berm*. The side of the ditch adjacent to the parapet is termed the *scarp*; the side opposite to this, the *counterscarp*. A mound of earth placed in front of the counterscarp, with a gentle slope outwards, is termed the *glacis*. To obtain speedy cover, the parapet is formed from a ditch within, termed a *trench*, of sufficient depth, with the height of the parapet, to give shelter to the troops when standing in the trench. The natural ground serves as the banquette tread in this case.

The measures taken for the attack and defense of fortifications have an interdependence so intimate that the dispositions made by the one party naturally control those that the other may make. The assailing force naturally seeks to advance on those points which offer the least obstruction, either by their passive strength or by the fire which sweeps the ground over which the advance has to be made. The most favorable case for the assailant will be where no fire from the assailed sweeps over the ground along which he advances; the next is where, although the missiles of the assailed sweep above the approach, they pass so high above the assailant as to inflict no injury. See *Field-intrenchments, Field-works, Flanked Disposition, Fortification, Inclosed Works, Line of Works, Profiling*, and *Tracing*.

FIELD-GLASS.—The double or binocular telescope, constructed optically on the principle invented by Galileo, and designed to give clear and distinct views of natural scenery by sea or land. Each tube of the glass contains a convex or magnifying achromatic object lens and a concave or negative eye-lens, which are placed at nearly the distance of their focal length apart. Thus, if the object-lens is of five inches focus and the eye-lens of one inch negative focus, the length of the bodies will be about four inches and the power will be about five times. To obtain a greater magnifying power with glasses constructed on the Galilean principle, the distance between the object- and eye-lenses must be increased until the limit of convenient portability is reached, which is found to be about eight times. If it be desired to apply the principle of binocularity to higher powers, an ordinary refracting telescope must be employed. The field- or marine-glass being intended for all out-door use, and being necessarily employed in hazy weather or after nightfall, is constructed with large object-lenses for the light-gathering, and with shades to extend beyond both the object-glasses, to shield the latter from sun or rain.


Gem Field-glass.

Their frames are made very substantially, to endure the rough handling to which they may be subjected, and they are carried in strong sole-leather cases, with straps for slinging over the shoulders. But they are bulky and heavy, rendering it very desirable that a glass combining their good qualities with greater portability and lightness should be procurable for many purposes. These desiderata are fully realized in the Gem, a glass manufactured by Walmsley & Co., and largely issued by the United States Government to officers serving on the Plains.

FIELD-GUN.—A small kind of gun or cannon used on the battle-field. Often called a field-piece. See *Field-artillery*.

FIELD-HOSPITAL.—The Staff and apparatus for the surgical treatment of the wounded in the field, and the locality assigned for the resort of the latter to obtain it. In the United States there is a hospital at every military post, under the superintendence of the Medical Department. In the French army the service of the field-hospitals forms part of the intendance of the army, the Medical Officers in charge being under the supreme control of the Intendant General. See *Hospitals*.

FIELD-INTRENCHMENTS.—When positions are to be taken up and lines of intrenchments or detached works are to be constructed, it is the duty of artillery officers, in co-operation with those of engineers, to select positions for batteries and determine the kind and amount of armament therefor. It is therefore necessary that they should be thoroughly conversant with the principles of military engineering, and especially those of field-intrenchments. The object of every fortification is to shelter the troops occupying it from the view and fire of an assailant, and at the same time to afford them a commanding view and sweeping fire over their enemy. Earth is the principal material employed on land for resisting the fire of artillery. Wood, iron, and masonry are used in conjunction with it, principally for sustaining purposes. As a material for fortifications, earth possesses advantages over all other, being found ready at hand in almost all localities where wanted for such purposes, being easily handled, and possessing unrivaled properties of resistance as a covering mass against projectiles.

Field-intrenchments may be classified as follows: 1. Intrenched camps; 2. Intrenched lines of battle; 3. Detached works; 4. Lines of works; 5. Works auxiliary to permanent fortifications; 6. Works for siege-operations. So far as artillery is concerned, the first object to be considered is position, the general principles of which are the same for each of the above classes, and which may be briefly stated as follows: 1. Artillery should, if possible, overlook all the ground within range over which an enemy might advance, and the pieces be so placed as to sweep the entire surface with their fire, those of longest range occupying the most commanding positions. 2. All the lines of approach of the assailant should be swept not only by the frontal, but by the flank or cross fire of the assailed. 3. The features of the ground should screen the assailed from the assailant's view, and afford cover from his fire whilst that of the assailed can be delivered with full effect. 4. The position should, if possible, present natural obstructions to the advance of the assailant. 5. It should offer no obstructions to the free movements of the assailed, either for the offensive or defensive, and should afford facilities for active offensive movements at the opportune moment. 6. It should have secure supports, both on its flanks and in the rear. 7. It should afford every convenience for encamping and being supplied. See *Field-fortification, Intrenched Camps*, and *Intrenchment*.

FIELD MARSHAL.—The highest rank of General Officers in the British and other foreign armies. In the former it is a special honor enjoyed by very few officers, and only conferred by selection, either on the ground of distinguished service or of royal birth. When unemployed, the Field Marshal has no higher pay than any other General, but if commanding an army he receives £16 8*s*. 9*d*. a day for staff-pay, while a General has but £9 9*s*. 6*d*. The equivalent rank in the Navy is that of Admiral of the Fleet. Formerly a Captain General was occasionally appointed, who had rank higher even than a Field Marshal.

FIELD OFFICER.—An officer above the rank of Captain and below that of General. Thus a Major, Lieutenant Colonel, or Colonel, whether of brevet or regimental rank, is a Field Officer. A Field Officer in the English army in command of his regiment retains the command for five years, but can be reappointed at the will of the Commander-in-Chief.

FIELD OFFICER'S COURT.—In the United States service, a Court-Martial consisting of one Field Officer empowered to try all cases, subject to jurisdiction of Garrison and Regimental Courts. It takes the place of the latter Courts in time of war, but cannot be held in time of peace. See *Courts-Martial*.

FIELD OF THE CLOTH OF GOLD.—A plain near Guisnes, in the Department of Calais, France, where Henry VIII. of England and Francis I. of France held a conference in June, 1520. The Throne of France was sought for by Charles I. of Spain (afterwards Charles V.), and Francis sought the friendship of the English King. To bring about such a result Francis proposed to raise Cardinal Wolsey to the Papacy. Wolsey brought about and conducted the meeting, which was attended with so much splendor of pageantry as to give the peculiar title to the place. The solemnities occupied nearly three weeks. Ten days were spent in the feats of arms for which Wolsey had provided. There were tilting with lances, and tourneys on horseback with the broadsword, and fighting on foot at the barriers. The Kings were always victorious against all comers. On Midsummer Day the gaudy shows were over.

FIELD-PARK.—The spare carriages, reserved supplies of ammunition, tools, and materials for extensive repairs and for making up ammunition, for the service of an army in the field, form the field-park, to which should be attached also the batteries of reserve. See *Park*.

FIELD-REMEDIES.— Peculiar and local diseases prevail in nearly every section of country; and wounds from gun-shot and weapons, bruised and broken bones, are casualties that may befall soldiers in the field at any time. It is, therefore, important for all to have, in cases of emergency, a sufficient knowledge of medicine and practical surgery to enable them to relieve the sick and wounded until professional aid can be secured. It is not necessary to provide a very extensive collection of medicines, etc. The list detailed for the *medicine-chest* will be found sufficient. Many natural remedies present themselves in all localities, and very simple modes of treatment, if understood, will relieve much suffering. The following remedies and modes of procedure should be carefully noted, as it is quite impossible to experience even a brief service in the field, without the necessity of resorting to some of them:

Scurvy may be prevented by employing the following antiscorbutics: 1. Any fresh vegetables, wild onions, fresh fruit, and even unripe fruit, with a risk of diarrhea. 2. Dried or canned vegetables, especially potatoes and cauliflower. 3. Vinegar, citric acid or lemon-juice. 4. Citrates, malates, tartrates and lactates of potash, used in food or drink. 5. Pure air, exercise, and cleanliness. 6. Tincture of chloride of iron, taken daily, or infusion of hemlock-leaves. 7. Raw potatoes and fresh raw meat. *Malaria* should be promptly checked. Quinine in sufficient doses is the remedy. A halt to the leeward of a marsh or swamp should be avoided. A camp on low ground is often less affected by malaria than the low hills that overlook it. Violent exertion, resulting in exhaustion and perspiration, often averts an attack, and any simple aperient is likewise good. *Diarrhea* may be treated with an ounce of castor-oil and fifteen drops of laudanum suspended in water. The patient should eat neither bread nor meat, but confine his diet to a little rice-broth, thickened milk, and the like. If it is accompanied by severe cramps, apply hot rocks or pans to the feet and hot fomentations to the stomach. *Poisoned* persons must be treated with the greatest caution, inasmuch as it is necessary to deal with dangerous remedies. Some poisons are best ejected by vomiting, and an emetic should be promptly given; in others, the action on the stomach may be diminished by oily and mucilaginous drinks, such as magnesia, milk and oil, barley-water, flour and water, and raw eggs. For poisonous acids, such as nitric, oxalic, muriatic, or sulphuric acid, avoid emetics. For nitrate of silver, give plenty of salt water, followed by barley-water or gruel. For strychnine, narcotic poisons, opium, mushrooms, belladonna, etc., give strong emetics at once, pour cold water on the head, neck, and shoulders, place mustard-poultices on the feet, and keep the person moving about, giving strong coffee as a stimulant. Water should always accompany the emetic, to make the vomiting easy, and great effort made to prevent the patient from becoming drowsy and stupid. A charge of gunpowder swallowed in water, mustard in hot water, or warm soapsuds are prompt emetics. In the absence of all these, a careful tickling of the throat often does the work. The following are good poultices: *Mustard-poultice*—two ounces powdered mustard, two ounces linseed-meal, eight ounces boiling water; *Charcoal-poultice*—one third ounce charcoal, two ounces bread, one ounce linseed-meal, eight ounces boiling water. For *suffocation by gases, etc.*, remove the patient to pure air, apply cold water to the face and chest, rub the body briskly, give hot coffee or spirits, and endeavor to induce artificial respiration.

For *sore and blistered feet*, undiluted whiskey and melted tallow rubbed on the foot, which is afterwards covered with a sock, act well. Great relief is found in tepid bathing, a small quantity of alum or salt being dissolved in the water. The feet should be washed daily, while on the march, and both the feet and inside of the stockings should be well soaped. In severe cases of soreness, a raw egg broken in the boot before putting it on is a splendid antidote. Blisters of the feet should not be opened, but a thread should be drawn through them and the liquid allowed to run off. If the foot-soreness is simply owing to bad boots or socks, relief may be often found by changing the boots and socks from one foot to the other, and turning the stockings inside out. *Chafing* is remedied by keeping the parts clean and powdering with fuller's earth. Sprains are relieved by hot fomentations and by rags kept saturated with cold water and bound round the parts. *Burns and scalds* are treated by keeping them from exposure to the air and applying carron-oil (a mixture of equal parts of oil and lime-water), flour, or scraped potatoes. *Snow-blindness* is an affection to be met with in all localities where there are glaring sheets of snow. Some persons are simply blind, others experience great pain, the lips chapping, and the face and exposed parts severely blistering. A person having once experienced snow-blindness is subject to frequent attacks. Green or blue glasses and a green-lined broad-brimmed hat give to the eyes protection. In the absence of glasses, wet powder and grease, or charcoal, smeared on the nose and about the eyes, will afford much relief. A few drops of opium, in tincture, placed within the eyelids will also afford relief. Water and weak brandy is an excellent eye-wash. For *sunstroke*, remove the collar and stock, loosen the shirt and coat, and continue to throw cold water on the head and spine until consciousness returns. For *wasp and scorpion stings, etc.*, extract the sting, if it remains in the wound, and rub acetic acid, the nicotine from a pipe, or chewed tobacco, upon the wound.

Rattlesnakes and venomous reptiles are met with in most localities, and their bites are of frequent occurrence. As an antidote the Western mountaineers of America place great dependence on strong whiskey. The action of the poison seems to counteract the effects of the whiskey, and a very large quantity may be taken without causing intoxication. No time should be lost in administering the spirits. Hartshorn applied externally and taken internally, in small doses, is a good remedy. Plaintain-leaves finely chewed and applied to the wound, after sucking out the poison, are also good. Pulverized indigo made into a soft poultice will draw out the poison when applied to the wound. The poison turns the indigo white. When the indigo ceases to change color it is a sign that the poison has been withdrawn. In the absence of antidotes, tie a ligature as firmly as possible above the wounded part, suck the wound, if the mouth and lips be free from sores, and caustic it. If no caustic be at hand, explode gunpowder into the wound, or burn it out with the end of a bayonet or ramrod heated to a white heat, avoiding the arteries. Use every effort to prevent the patient from falling into the lethargy and drowsiness that always follow. The following cruel course is often taken by the Indians of the Northwest in treating a poisonous bite: A bird or animal with a quick circulation of the blood is secured, an incision is made into the flesh of the creature and placed in contact with the wound. The bird or animal soon dies. This is repeated several times until the contact produces no effect, when the victim is considered out of all danger. A bandage is generally placed between the wound and the heart to prevent the return of venous blood.

The following is the proper treatment of the apparently dead from intense cold: Rub the body with snow, ice, or cold water. Restore warmth gradually; and after some time, if necessary, employ the means recommended for the drowned. In these accidents it is very dangerous to apply heat too early. In order to restore the natural warmth of the body, move a heated warming-pan over the back and spine, and rub the body briskly with the hands. To restore breathing, place the pipe of a common bellows (when procurable) into one nostril, carefully closing the other and the mouth; at the same time push gently downwards and backwards the upper part of the windpipe, so as to allow a freer admission of air; blow the bellows gently to inflate the lungs, until the breast be slightly raised; the mouth and nostrils should then be set free, and a moderate pressure with the hand brought to bear upon the chest. Repeat this process until life appears. Any of the following may be useful helps: 1. The application of sal-volatile or hartshorn to the nostrils. 2. The early employment of electricity by a skillful person. 3. The injection of half a pint of warm brandy and water, or wine and water, into the stomach. See *Medicine-chest*, *Military Surgery*, *Swimming*, and *Wounds*.

FIELD-SERVICE.—In the United States, the formation by divisions is the basis of the organization and administration of armies in the field. A division consists usually of two or three brigades, either of infantry or cavalry, and troops of other corps in the necessary proportion. A brigade is formed of two or more regiments. As the troops arrive at the rendezvous, the General Commanding-in-Chief organizes them into brigades and divisions. Brigades in divisions and divisions in corps receive permanent numerical designations, as first, second, and third. In a single army, corps are designated in like manner. If there be more than one army, corps are numbered consecutively from the first to the last one organized. In reports of military operations, brigades and divisions are designated by the name of the General commanding them. The General Commanding-in-Chief assigns the Generals of divisions and of brigades to their respective commands, when the assignment is not made by the Department of War. The General of Brigade inspects his troops in detail, by companies, when he takes the command and at the opening of the campaign, and as often as may be necessary to ascertain exactly their condition. The General of Division makes similar inspections when he thinks proper. At these inspections the Generals examine the arms, clothing, equipments, harness, horses, etc., direct the necessary repairs, and designate the men and horses to remain in depot or march with the train. Staff Officers, and Officers of Engineers, Ordnance, and Artillery, according to the nature of the service, are assigned to the headquarters of armies and divisions, and detached brigades, by order of the General Commanding-in-Chief, when the distribution of these officers has not been regulated by the War Department. The necessary Staff is also assigned to Commanders of Brigades. The report of the Officer of Engineers embraces plans of military works executed during the campaign, and, in case of siege, a journal of the attack or defense.

At the opening of a campaign, the Commander of an army determines and announces in orders the number of orderlies, mounted or foot, for the Generals. Orderlies for Corps, Division, and Brigade Commanders of Infantry are detailed from the Infantry, and are mounted; for Artillery and Cavalry Commanders, from their commands. In marches, the mounted orderlies follow the Generals, and perform the duty of escorts, or march with orderlies on foot at the head of the division or brigade. The Staff Officer who distributes the orderlies to their posts sends with them a note of the time and place of departure; those relieved receive a like note from the Staff Officer at the headquarters.

In active campaign, troops should be prepared to bivouac on the march, the allowance of tents being limited, about as follows: For the headquarters of an army corps, division, or brigade, one wall-tent to the Commanding General, and one to every two officers of his Staff. For the Colonel, Field, and Staff of a full regiment, three wall-tents; and for every other commissioned officer, one shelter-tent each. For every two non-commissioned officers, soldiers, officers' servants, and authorized camp-followers, one shelter-tent. One hospital-tent is allowed for office purposes at corps headquarters, and one wall-tent at those of a division or a brigade. Hospital-tents are for the sick and wounded, and, except those allowed for army corps headquarters, should not be diverted from their proper use. Officers' baggage is limited to blankets, one small valise or carpet-bag, and a moderate mess-kit. The men carry their own blankets and shelter-tents, and reduce the contents of their knapsacks as much as possible.

Reconnoissances should precede the establishment of a camp. For a camp of troops on the march, it is only necessary to look to the health and comfort of the troops, the facility of the communications, the convenience of wood and water, and the resources in provisions and forage. For an intrenched camp, or a camp to cover a country, or one designed to deceive the enemy as to the strength of the army, the ground must be selected, and the camp arranged for the object in view. The camping-party of a regiment consists of the Regimental Quartermaster and Quartermaster Sergeant, and a Corporal and two men per company. The General decides whether the regiments camp separately or together, and whether the police guard shall accompany the camping-party, or a larger escort shall be sent. The watering-places are examined, and signals placed at those that are dangerous. Any work required to make them of easier access is done by the police guard or Quartermaster's men. Sentinels, to be relieved by the guards of the regiment when they come up, are placed by the camping-party over the water if it is scarce, and over the houses and stores of provisions and forage in the vicinity. If the camping-party does not precede the regiment, the Quartermaster attends to these things as soon as the regiment reaches the camp. On reaching the ground, the infantry form on the color front, the cavalry in rear of its camp. The number of men to be furnished for guards, pickets, and orderlies; the fatigue-parties to be sent for supplies; the work to be done, and the strength of the working parties; the time and place for issues; the hour of marching, etc., are then announced by the Brigadier Generals to the Colonels, and by them to the Field Officers. The artillery is parked near the troops to which it is attached, so as to be protected from attack, and to contribute to the defense of the camp. Sentinels for the park are furnished by the artillery, and, when necessary, by the other troops. In the cavalry, each troop moves a little in rear of the point at which its horses are to be secured, and forms in one rank; the men then dismount; a detail is made to hold the horses; the rest stack their arms and fix the picket-rope; after the horses are attended to, the tents are pitched, and each horseman places his carbine at the side from the weather, and hangs his saber and bridle on it. The standard is then carried to the tent of the Colonel. The front of the camp is usually equal to the front of the troops. The tents are arranged in ranks and files. The number of ranks varies with the strength of the companies and the size of the tents. The Staff Officer charged with establishing the camp designates the place for the shambles.

When bivouacking, the distance from the enemy decides the manner in which the horses are to be fed and led to water. When it is permitted to unsaddle, the saddles are placed in the rear of the horses. For infantry, the fires are made in rear of the *color-line*, on the ground that would be occupied by the tents in camp. The companies are placed around them, and, if possible, shelters are made. When liable to surprise, the infantry should stand to arms at daybreak, and the cavalry mount until the return of the reconnoitering parties. If the arms are to be taken apart to clean, it must be done by detachments, successively.

When in cantonment, the Regimental Commander indicates the place where the command shall assemble in case of alarm. It should generally be outside the cantonment; the egress from it should be free; the retreat upon the other positions secure, and roads leading to it on the side of the enemy obstructed. Near the enemy, companies or platoons should be collected, as much as possible, in the same houses. If companies must be separated, they should be divided by platoons or squads. When cavalry and infantry canton together, the latter should furnish the guards by night, and the former by day. Troops cantoned in presence of the enemy should be covered by advanced guards and by natural or artificial obstacles. Cantonments taken during a cessation of hostilities should be established in rear of a line of defense, and in front of the point on which the troops would concentrate to receive an attack. The General Commanding-in-Chief assigns the limits of their cantonments to the divisions, the Commanders of Divisions to brigades, and the Commanders of Brigades post their regiments. The position for each corps in case of attack is carefully indicated by its Commanding Officer.

The General who establishes an intrenched post gives to its Commander detailed instructions in regard to its defense, and to the circumstances under which the defense should cease. The Commander reconnoiters his post; distributes the troops; posts the officers and non-commissioned officers; forms a reserve; gives orders for all contingencies he can foresee, and arranges his troops so as to prepare them for attack, day or night.

The grand depots of an army are established where the military operations would not expose them to be broken up. Smaller depots are organized for the divisions and for the several arms. They are commanded by officers temporarily disabled for field-service or by other officers if necessary, and comprise, as much as possible, the hospitals and depots for convalescents. When conveniently placed, they serve as points for the halting and assembling of detachments. They receive the disabled from the corps on the march; and the officers in command of the depots send with the detachments to the army those at the depots who have become fit for service. In the field verbal orders and important sealed orders are carried by officers, and, if possible, by Staff Officers. When orders are in writing, the place and time of departure should be marked on them, and place and time of delivery on the receipt. Dispatches, particularly for distant corps, should be intrusted only to officers to whom their contents can be confided. In a country occupied by the enemy, the bearer of dispatches should be accompanied by at least two of the best mounted men; should avoid towns and villages, and the main roads; rest as little as possible, and only at out-of-the-way places. Where there is danger, he should send one of the men in advance, and be always ready to destroy his dispatches. He should be adroit in answering questions about the army, and not be intimidated by threats. The precise time when the dispatch is sent off, and the rate at which it is to be conveyed, should be written clearly on the covers of all letters transmitted by a mounted orderly, and the necessary instructions to him, and the rate of travel going and returning, should be distinctly explained to him. The parole and countersign are issued daily from the principal headquarters of the command. The countersign is given to the sentinels and non-commissioned officers of guards; the parole to the commissioned officers of guards. When the parole and countersign cannot be communicated daily to a post or detachment which ought to use the same as the main body, a series of words may be sent for some days in advance. If the countersign is lost or one of the guard deserts with it, the Commander on the spot substitutes another, and reports the case at once to the proper Superior, that immediate notice may be given to headquarters.

When the wants of the army absolutely require it, and in other cases, under special instructions from the War Department, the General Commanding the Army may levy contributions in money or kind on the enemy's country occupied by the troops. No other Commander can levy such contributions without written authority from the General Commanding-in-Chief.

While the general laws and necessity of war may, in certain cases, justify the seizure and conversion of private property for the subsistence, transportation, and other public uses of the army, yet the Rules and Articles of War denounce the severest penalties against pillage, and the taking or appropriation of property for private purposes, whether the offense be committed within the United States or in an enemy's country. All property, public or private, lawfully taken from the enemy, or from the inhabitants of an enemy's country, by the forces of the United States, instantly becomes the public property of the United States, and must be used and accounted for as such. It is forbidden to purchase horses without ascertaining the right of the party to sell. Estrays, in the enemy's country, when the owner is not discovered, are taken for the army. Officers are held strictly responsible that all property taken from alleged enemies by them, or with their authority, is inventoried and duly accounted for.

A police guard is detailed in each regiment daily, consisting of two Sergeants, three Corporals, two drummers, and men enough to furnish the required sentinels and patrols. An advanced-post is detached from the police guard, composed of a Sergeant, a Corporal, a drummer, and nine men to furnish sentinels and the guard over the prisoners. The men are the first of the guard roster from each company. The men of the advanced-post must not leave it under any pretext. Their meals are sent to the post. The advanced-post furnishes three sentinels—two a few paces in front of the post, opposite the right and left wing of the regiment, posted so as to see as far as possible to the front, and one over the arms. In the cavalry, dismounted men are employed in preference on the police guard. The mounted men on guard are sent in succession, a portion at a time, to groom their horses. The advanced-post is always formed of mounted men. The police guard and the advanced-post pay the same honors as other guards. They take arms when an armed body approaches.

Deserters from the enemy, after being examined, are secured for some days, as they may be spies in disguise; as opportunities offer they are sent to the rear; after which, if they are found lurking about the army, or attempting to return to the enemy, they are treated with severity. The arms and accouterments of deserters are turned over to the Ordnance Department, and their horses to the corps in want of them, after being branded. The enlistment of deserters from the enemy, without express permission from General Headquarters, is prohibited. Plundering and marauding, at all times disgraceful to soldiers, when committed on the persons or property of those whom it is the duty of the army to protect become crimes of such enormity as to admit of no remission of the awful punishment which the military law awards against offenses of this nature.

The picket is detailed daily after the details for duty of the first class, and from the next for detail on the roster of that class. It is designed to furnish detachments and guards unexpectedly called for in the twenty-four hours; it counts as a tour of the first class to those who have marched on detachment or guard, or who have passed the night in bivouac. The picket of a regiment is composed of a Lieutenant, two Sergeants, four Corporals, a drummer, and about forty privates. For a smaller force the picket is in proportion to the strength of the detachment. The picket is assembled by the Adjutant at guard-mounting; it is posted twelve paces in rear of the guard, and is inspected by its own Commander. When the guard has marched in review, the Commandant of the picket marches it to the left of the police guard, where it stacks its arms and is dismissed. The officers, non-commissioned officers, and soldiers of the picket are at all times dressed and equipped; the horses are saddled, and knapsacks and valises ready to be put on. The picket does not assemble at night except in cases of alarm, or when the whole or a part is to march; then the Officer of the Day calls the officers, who call the non-commissioned officers, and the latter call the men; for this purpose each ascertains the tents of those he is to call. They are assembled without beat of drum or other noise. At night, cavalry pickets assemble mounted.

The grand guards should cover the approaches to a camp or cantonment. Their number, strength, and position are regulated by the Commanders of Brigades; in detached corps, by the Commanding Officer. When possible, the grand guards of cavalry and infantry are combined, the cavalry furnishing the advanced sentinels. When the cavalry is weak, the grand guards are infantry, but accompanied by a few cavalry soldiers, to obtain and carry intelligence of the enemy. The strength of the grand guard of a brigade depends on its object and the strength of the regiments, the nature of the country, the position of the enemy, and the disposition of the inhabitants. It is usually commanded by a Captain. Grand guards usually mount at the same time as the other guards, but may mount before daybreak if the General of Brigade thinks it necessary to double the outposts at that time. In this case they assemble and march without noise, and during their march throw out scouts—a precaution which should always be taken in the first posting of a grand guard. The doubling of guards weakens the corps and fatigues the men, and should seldom be resorted to, never when preparing to march or fight. The Commander of a grand guard receives detailed instructions from the General and Field Officer of the Day of the brigade, and instructs the Commanders of the small posts as to their duties and the arrangements for defense or retreat. If the small posts are to change their positions at night, they wait until the grand guard is in position and darkness hides their movements from the enemy; then march silently and rapidly under the charge of an officer.

In war, every Commander of a fortified place always holds himself prepared with his plan of defense, as if at any time liable to attack. He arranges this plan according to the probable mode of attack; determines the posts of the troops in the several parts of the works, the reliefs, the reserves, and the details of service in all the corps. He draws up instructions for a case of attack, and exercises the garrison according to his plan of defense. In sea-coast works, he provides the instructions for the different batteries on the approach of ships. In framing his plan, he studies the works and the exterior within the radius of attack and investment, the strength of the garrison, the artillery, munitions of war, subsistence and supplies of all kinds, and takes immediate measures to procure whatever is deficient of troops or supplies, either by requisition on the Government or from the means put at his disposal. On the approach of an enemy, he removes all houses and other objects, within or without the place, that cover the approaches, or interrupt the fire of the guns or the movements of the troops. He assures himself personally that all posterns, outlets, embrasures, etc., are in proper state of security. He should be furnished, if possible, with a plan of the works, showing all the details of the fortifications and of the exterior within the radius of attack; with a map of the environs within the radius of investment; with a map of the vicinity, including the neighboring works, roads, water-channels, coasts, etc.; with a memoir explaining the situation and defense of the place, and the relations and bearings of the several works on each other, and on the approaches by land and water—all which he carefully preserves, and communicates only to the Council of Defense.

The Commander defends in succession the advanced-works, the covered-way and outworks, the body of the work, and the interior intrenchments. He is not content with clearing away the foot of the breaches, and defending them by abatis, mines, and all the means used in sieges, but he begins in good time, behind the bastions or front of attack, the necessary intrenchments to resist assaults on the main work. He uses his means of defense in such manner as always to have a reserve of fresh troops, chosen from his best soldiers, to resist assaults, retake the outworks, and especially to resist the assaults on the body of the place; and a reserve of provisions for the last period of the siege, and of ammunition for the last attacks. He endeavors in every case to compel the besieging force to approach by the slow and successive works of siege, and sustains at least one assault on a practicable breach in the body of the place. When the Commander thinks that the end of the defense has come, he consults a Council of Defense on the means that may remain to prolong the siege. But in all cases he alone decides on the time, manner, and terms of the surrender. In the capitulation he does not seek or accept better terms for himself than for the garrison, but shares their fate, and exerts his best endeavors for the care of the troops, and especially of the sick and wounded. Near an enemy, daily réconnoissances are made to observe the ground in front, and to discover whether the advanced-guards of the enemy have been increased or put in motion, or any other sign of his preparation for march or action. Reconnoitering parties should observe the following precautions: To leave small posts or sentinels at intervals, to transmit intelligence to the advanced-posts of the army, unless the return is to be by a different route; to march with caution, to avoid fighting; and see, if possible, without being seen; to maintain an advanced-guard; to send well-mounted men ahead of the advanced-guard, and on the flanks of the party; to instruct the scouts that no two should enter a defile or mount a hill together, but to go one at a time, while one watches to carry the news if the other is taken. Special reconnoissances are made under the direction of the General Officer in command, by such officers and with such forces as he may direct. Offensive or forced reconnoissances are to ascertain with certainty points in the enemy's position, or his strength. They are sometimes preludes to real actions, and sometimes only demonstrations. They drive back his outposts, and sometimes engage special corps of his line. They are only made by the order of the General Commander-in-Chief, or the Commander of an isolated corps.

The strength and composition of the escort of a convoy depend on the country, the nature and value of the convoy, and the dangers it may incur. A larger escort is required for a convoy of powder, that the defense may not be near the train. The advance-guard precedes the convoy far enough to remove all obstacles to its advance. It examines the woods, defiles, and villages, and by mounted men gives information to the Commander, and receives his orders. It reconnoiters places for halts and parks. When the rear is threatened, the rear-guard defends the ground and retards the enemy by breaking the bridges and blocking the road. If the flanks are threatened, and the ground is broken, and many defiles are to be passed, the defense of the convoy becomes more difficult; the advance and rear guards must be reduced, the flanks strengthened, and positions which will cover the march of the convoy must be occupied by the main body of the troops before the head of the convoy reaches them, and until it has passed. If the convoy is large, and has to pass places that the force and position of the enemy make dangerous, the loss of the whole convoy must not be risked; it must pass by divisions, which reunite after the passage. In this case the greater part of the troops guard the first division; they seize the important points, and cover them with light troops, or, if necessary, with small posts, and hold them until all the divisions have passed. On the appearance of the enemy during the march, the Commander closes up the wagons and continues his march in order; he avoids fighting; but if the enemy seizes a position that commands his road, he attacks vigorously with the mass of his force, but does not continue the pursuit far from the convoy. The convoy halts, and resumes the march when the position is carried. When the enemy is too strong to be attacked, the convoy is parked in square if there be room; if not, closed up in double file, at the front and rear the road is blocked by wagons across it. The drivers are dismounted at the heads of the horses. They are not permitted to make their escape. The light troops keep the enemy at a distance as long as possible, and are supported when necessary, but prudently, as the troops must be kept in hand to resist the main attack. When a whole convoy cannot be saved, the most valuable part may sometimes be by abandoning the rest. If all efforts fail, and there is no hope of succor, the convoy must be set on fire and the horses killed that cannot be saved; the escort may then cut its way through. If the convoy be of prisoners of war, every effort should be made to reach a village or strong building where they may be confined; if forced to fight in the field, the prisoners must be secured and made to lie down until the action is over.

The wagons or pack-animals allowed to a regiment, battery, or squadron should carry nothing but forage for the teams, cooking-utensils and rations for the troops, hospital stores, and baggage. One wagon, or an equivalent of pack-animals, to each regiment should transport exclusively hospital supplies, under the direction of the Regimental Surgeon; the one for regimental headquarters should carry the grain for the officers' horses; and the three allowed for each battery or squadron should be loaded with rations and forage in proper proportions for the same number of days' supply of each. Stores in bulk and ammunition should be carried in the regular or in special supply-trains. In large commands the roads, if possible, are left to the artillery and trains. The order of march should state whether the troops or trains have the right of way. The order for the movement of the divisions, brigades, and regiments contains the necessary directions in regard to the assembling and marching of the respective trains. The several trains march in an order analogous to the rank of the Generals, and the order of battle of the troops to which they belong. Trains are not allowed in any case to be in the midst of the troops, or to impede the march of the troops. General Officers should not permit any General or Staff Officer or regiment under their orders, or any person whatsoever attached to their command, to have more than the authorized amount or means of transportation. For this purpose they should themselves make, and cause to be made, frequent reviews and inspections of the trains. They should see that no trooper is employed to lead a private horse, no soldier to drive a private vehicle, and that no trooper is put on foot to lend his horse to an officer. They should not permit the wagons of the artillery or of the train to be loaded with anything foreign to their proper service, nor any public horse, for any occasion, to be harnessed to a private carriage. It is the duty of the Medical Director, or Chief Medical Officer, of the army corps, previous to a march, and previous to and in time of action, or whenever it may be necessary to use the ambulances, to issue the proper orders for the distribution and management of the same, for collecting the sick and wounded and conveying them to their destination. And it is the duty of his assistants faithfully and diligently to execute such orders.

If two corps meet on the same road, they pass to the right, and both continue their march, if the road is wide enough; if it is not, the first in the order of battle takes the road, the other halts. A corps in march must not be cut by another. If two corps meet at cross-roads, that which arrives last halts if the other is in motion. A corps in march passes a corps at a halt, if it has precedence in the order of battle, or if the halted corps is not ready to move at once. A column that halts to let another column pass resumes the march in advance of the train of this column. If a column has to pass a train, the train must halt, if necessary, till the column passes. The column which has precedence must yield it if the Commander, on seeing the orders of the other, finds it for the interest of the service. Dispositions for battle depend on the number, the kind, and quality of the troops opposed, on the nature of the ground, and on circumstances which it is impossible to anticipate; and therefore the general disposition is left to the judgment and discretion of Commanding Officers. In making an attack, the communications to the rear and for retreat should be secured, and the General should give beforehand all necessary orders to provide for that event. During the fight the officers and non-commissioned officers keep the men in the ranks, and enforce obedience if necessary. Soldiers should not be permitted to strip or rob the dead, nor even to assist the wounded, except by express permission, which is only to be given after the action is decided. The highest interest and most pressing duty is to win the victory, by winning which only can a proper care of the wounded be insured. Before the action, all the necessary arrangements are made for the transportation of the wounded. Ambulance-depots are established in the rear, and necessary instructions are given for the service of the ambulance-wagons and other means of removing the wounded. A General Commanding in the Field or a Department makes arrangements for the safe-keeping and reasonable comfort of his prisoners. For this purpose he may appoint a Provost Marshal to take charge of them, and place them under a guard already on duty, or detach a guard for the special service. The General gives no order exchanging prisoners, or releasing them, except under instructions from the Secretary of War. In emergencies admitting of no delay he may act upon his own authority, and give any order in relation to his prisoners the public interest may require, promptly reporting his proceedings to the War Department.

FIELD-STAFF.—A staff formerly carried by gunners in the field, and holding lighted matches for discharging cannon. It is no longer used.

FIELD STATE.—A statement made over to the Superior or Reviewing Officer on parade, showing the number of officers and men composing the troops, distinguishing those present and absent (on whatever account in the latter case), all under their respective headings.

FIELD-TELEGRAPHY.—The electric telegraph is a novel element of war. England was the first to apply it to military operations. During the siege of Sebastopol telegraphic lines were established by the allied armies, and later, during the Indian Mutiny, a first attempt was made to organize a field-telegraph, which succeeded admirably under the direction of the late Captain Stewart of the Bengal Engineers. In 1859 the French army was accompanied by a large *personnel* belonging to the civil telegraphic administration, whose duty was to establish a service during the marches. The war in America, and that between Austria and Prussia in 1866, showed convincingly the importance of such an introduction into military operations. Permanent lines on a large extent were established and worked by the troops; all those that existed in the zone of operations of the armies were seized. Trains of a special field-material followed each corps, to be used on the march, in cantonments, and even on the field of battle. In 1866 the Prussian and Austrian armies employed, to a great extent, telegraphic lines during the marches and maneuvers that preceded Sadowa. The war of 1870-1871 is another instance of the immense advantages that can be derived from the use of the electric telegraph when well organized and employed. During the latter end of the war, Manteuffel and Werder, operating in the East separately and on different lines, were able to combine their movements and to receive direct instructions from the headquarters at Versailles by means of the wire. The Telegraphic Department in time of war may be divided into two distinct branches. The first comprehends the seizure and use of all permanent lines existing in the country in which the operations are carried on, or, in the absence of these, the creation of new lines of the same kind. The influence of the telegraph is very great, as it enables the General in Command, as long as the opposing armies are concentrated, to transmit intelligence and directions between his headquarters and the rear of his army, or between himself and the Generals commanding wings. The organization and working of such lines should keep pace with the rapid transport by rail of troops and supplies. Whether already existing or newly created, it is considered as a general rule that within the zone of operations an army should exclusively dispose of all the lines indispensable for its correspondence, and that these should be carefully watched over, whilst those that are not necessary and might fall into the hands of the enemy should be destroyed. The second branch of this Department comprehends the transport, the establishment, and the working of mobile lines, known as the *field-telegraph.* These are used when the opposing armies are in presence of each other, and on an extended fron and in cases when concentrated action is essential to success. By the field-telegraph, *corps d'armée* are placed in intimate communication with each other, and are connected with their base of operations by means of the permanent lines. On the march the telegraph can easily be laid down as each column advances, and thus the Commander-in-Chief be placed in communication with the whole of his army. In certain cases, when circumstances permit of it, the field-telegraph, as was seen during the Indian Mutiny and later wars, can be brought on the battle-field, following closely the combatants. Lines of a light nature can move easily with armies in the field, and can subsequently be replaced by others of a more solid material, called *semi-permanent,* if communication is to be kept up for any length of time. Field, semi-permanent, and permanent telegraphs differ in materials and manner of laying. The *field-telegraph* should be of such a nature that it can be constructed or taken up at the same rate as an infantry regiment marches. The *semi-permanent telegraph* is constructed of more solid material and substantial wire; its weight, including the poles, should not exceed one ton per mile, and it should be of such a nature as to be laid at a rate of from 20 to 30 miles per day for every 100 men employed. The wires are suspended from poles, trees, or in any other convenient mode. The *permanent telegraph* can be constructed at the rate of 10 miles a day. There is a point below which the electric telegraph ceases to be advantageous over other modes of communicating intelligence, such as is carried on by signaling and by mounted orderlies. The handing-in, the transmitting, and the receiving of a telegram require a certain amount of time which may be longer than that necessary for a mounted orderly to cross the distance between the two places. The electric telegraph, therefore, should only be made use of for distances of eight miles and upwards. In England the military telegraph is worked by a branch of the Royal Engineers, of which there is one troop. At present this troop is composed of three officers and 245 non-commissioned officers and men; 12 wagons, each carrying 3 miles of insulated wire, rolled on 6 drums for paying-out, and iron rods for carrying over roads. A telegraph-troop forms 3 sections composed of 3 traveling offices, 3 general-service wagons, and 3 artificers' wagons. In time of war this branch of the service would be placed, in each army corps, under the immediate control of a Director of Telegraphs, with an assistant. His chief duty should be to keep up the communication between corps and divisions and headquarters. He should never be without one or two alternative lines, in case of accidents, and be always prepared to alter and adapt existing lines. Between important points there should be two or more separate lines, remembering that the sole value of telegraphs lies in their security. Every effort should be made to watch over the telegraphic lines used by an army in the field, and to destroy those of the enemy. Their destruction is easily executed; and this duty generally devolves on cavalry. It is sufficient to pull down the poles, and to cut them in several pieces, or carry away as much of the wire as possible; to destroy the insulators as well as the instruments and batteries found in telegraphic stations. A non-conducting wire, having the outward appearance of an ordinary wire, can be used also for destroy-

Fig. 1.

ing communication by splicing it to the electric wire in one or two places along the line. The result will be that all galvanic communication will be stopped, and it will be difficult to discover where the break exists. In telegraphy, as well as in the other branches of military art, it is important to be acquainted with the resources of the country, and to take as much advantage of these resources as is possible. These are obtained by means of reconnaissances, and note must be taken of the plan and direction of all existing lines, and the advantages that may accrue from them by connecting them with other stations; the number and kind of instruments used in the stations; whether the roads to be traversed by the army are planted with trees or posts on which the wires can be set up; and whether the neighboring woods can furnish timber for the posts.

Assuming that the reader is unacquainted with the details of telegraphy, we will briefly describe the construction and operation of a field-telegraph. It is from the action created in the battery that is first generated the electric current, which, in field-telegraphy, is made to traverse long or short distances through the conducting medium of metallic wires, and this current of electricity, so generated in the battery, and so conducted through the wires, is then, by means of the proper instruments, made to give out tangible signals, which, being arranged in the form of an alphabet, enables us to read or speak as it were from any great distance, and this instantaneously; for the electric current requires but a small fraction of a second's time to travel many hundreds of miles through the wires.

Where currents more powerful than can be produced by a single cell are required, additional cells are added by connecting either the copper or zinc pole of the first cell to the opposite pole of the next, and so on (Fig. 1); so that in a series of fifteen or twenty cells, if the unconnected pole of the cell at one end were copper, that pole would constitute the copper pole of the entire battery, and the unconnected zinc at the other end would be the zinc pole of the entire battery. By connecting the end of a wire of any length to the zinc or copper pole of such a battery, and its opposite end to the remaining pole, a much more powerful current would pass through the wire than if the battery consisted of but one cell. Telegraph Companies on their long lines use batteries of from twenty to one hundred cells each. To put the battery in operation, fill the glass jar about two thirds full of water; place the copper in the bottom so that it rests as nearly level as possible, and its wire passing straight upward at one side of the jar. Then drop about half a pound of sulphate of copper into the jar so the lumps will lie evenly on the bottom or around and on the copper. Then suspend the zinc so this battery depends very much upon the position in which the zinc is placed with reference to the copper. To get the most active effect, lower the zinc to within about an inch of the copper, taking care not to allow a contact between the two. To decrease the power and render the battery more constant or lasting, raise the zinc farther away from the copper. Mention is made of the use of wire as the means of conducting currents of electricity from one pole of a battery to any given point, and thence back to the opposite pole, making the "circuit," as it is called, complete. Certain substances are found to conduct electricity with more or less facility, and these substances are called conductors, while through other matter no currents whatever will pass. The latter class of substances are called non-conductors or insulating mediums. In telegraphy there are used as conductors, principally, copper, iron, brass, and platina. As insulation, gutta-percha, hard and soft rubber, glass, silk and cotton fiber, dry wood, bone and ivory. Iron in the shape of wire is usually employed for outside conductors, because of its durability, cheapness, and strength, although it is not as perfect a conductor as copper, which latter is generally used for all wires inside of buildings and offices. In conducting currents of electricity from one point to another, as in telegraphy, it is found necessary to use non-conduct-

Fig. 2.

that the body of the wheel is about two inches above the copper. As the battery does not at once begin to act in its fullest strength when newly set up, it is well to connect the copper with the zinc and leave it so for a few hours before using. This is done by fastening the wire from the copper into the screw-post of the zinc hanger, and will soon cause the battery to work up sufficiently to be ready for use. The battery should be kept supplied with enough sulphate of copper so that a blue color can always be seen in the liquid at the bottom of the jar, rising to within an inch of the lower surface of the suspended zinc. If it is found that the blue color rises higher than this, it is thereby indicated too much sulphate of copper is being used, and no more should be put in until the blue has receded almost to the very bottom of the jar. The latter state of the battery indicates that more sulphate of copper is required. Water should be from time to time added to that in the jar to replace the loss by evaporation. Once in two or three months it will be necessary to thoroughly clean the battery. Take out the zinc carefully; then the copper in the same manner; pour the liquid into a separate jar, leaving behind the oxide and dirt which may have gathered in the bottom of the jar. Wash the latter out completely, and return to it the clean liquid which it had in it before; put back the copper to its place; put in a few crystals of sulphate of copper; clean the zinc thoroughly by scraping and washing, and return it also to its place. The battery will then be in good order, and should not be disturbed excepting when necessary to clean it or add sulphate. The power of ors wherever a fastening of the wire is made, in order to prevent an escape of the fluid at these numerous points. For this purpose glass is principally used for outside wires, the glass "insulators" being first made fast to the pole or building, whereon the wire is to be suspended by means of a wooden pin, or "bracket," after which the wire is strung and tied to the glass with a short piece of iron "tie-wire." Inside of offices hard and soft rubber tubes are used where the wires pass through the windows, and the copper conducting-wires are usually covered with a coating of gutta-percha, or wrapped with a continuous covering of cotton or silk. The latter is principally used as a covering for the wires inside the finer instruments. For the handles or knobs to the various instruments which require manipulation, hard rubber is generally used. It is found that when one pole of a battery is connected with the earth, and the wire from the opposite pole carried to a point at any distance away, and also connected with the earth, the current will flow as readily as though the "circuit" had been made complete by the use of a return-wire. It is therefore shown that the earth is practically one vast conductor. This is principally due to the fact that moisture is everywhere present beneath the surface of the earth, and water itself is known to be a very fair conductor. Telegraph Companies make great practical use of earth-conduction by using it in all cases for their numerous lines, both long and short, thus saving the construction of a separate or return wire on every circuit. A careful reading of the foregoing will have enabled the soldier to understand how currents of electricity are generated and made to travel through space. The next feature of the study will be the means which are employed to make these currents transmit signals. The basis of the entire telegraphic apparatus is the electro-magnet and the transmitting "key" (Fig. 2). The electro-magnet is constructed as follows: Two bars of soft iron, having round heads of rubber or wood, thus making spools of each, are fastened together by means of a short flat bar of iron similarly soft. The round bars in the spools of the magnet are called the "cores." The flat connecting-bar at the back is called the "back armature," by telegraphers, to distinguish it from the movable piece in front, which is to be attracted to the "cores" or withdrawn by the spring, and which is called the armature. A silk- or cotton-covered wire is wound in continuous turns about the cores until a diameter of about an inch and a half is attained, and each core or spool of the magnet contains a great number of turns of the wire around it. Now, if a current of electricity be sent through this wire, it will, by its passing through the numerous turns, cause the iron cores within to become magnetic and to possess the power of attracting with considerable force any piece of iron brought near to their ends. The cores, being made of soft iron, will lose their magnetism and cease to exert any attractive power the moment the current ceases to flow. The actual power of the attractive force thus exerted is directly dependent upon the power of the battery which supplies the current, or, more properly speaking, upon the power of the current itself. Strong currents will cause the magnets to attract with a power of several pounds. Keys are simply a contrivance for making or breaking the contacts which control the passage of the current—a brass lever swung on a pivot, having a rubber handle which the operator grasps lightly with the thumb and forefinger. On pressing the lever downward, a platina point projecting under the lever is brought into contact with another platina point set into an insulation of rubber in the base of the key, so that there can be no electrical connection between them unless the key is pressed down, or "closed" as it is termed. A conducting wire being separated at any point, and one of its ends connected with the lever or base of the key, and the other end with the metal set into the rubber insulation, would convey the current while the key was closed, and cease to do so the moment it was opened. Platina is used at the points where the electrical contacts are made and broken because it does not readily fuse or tarnish. An extra lever at the side of the key is called the "circuit-breaker," and is used as a means of keeping the circuit closed when the hand of the operator is not on the key. When the circuit-breaker is pushed into its closed position it makes contact with a brass lip, which latter is fastened to the rubber along with the lower platina point. This, then, has the same effect as though the key was pressed downward and contact made at the points. Fig. 2 represents a magnet with its armature suspended from a spring, and connected with it by a wire, a battery, and a key. From what has now been explained it may be seen that when the key is closed a current from the battery will pass through the wire and magnet, and cause the latter to attract the armature, overcoming the resistance of the spring, and that the instant the key is opened the current will cease to flow, the magnet cease to attract, and the spring will instantly draw the armature back to its original position. In this way the armature is made to follow exactly the movements of the key, no matter at what distance they may be placed from each other, although in practice it is found that as the circuits are lengthened, more battery power and more delicate instruments are required than on short lines. The whole basis of the telegraph system is this duplication at one point, by the magnet and its armature, of the motions made on the key by the hand of the operator, at

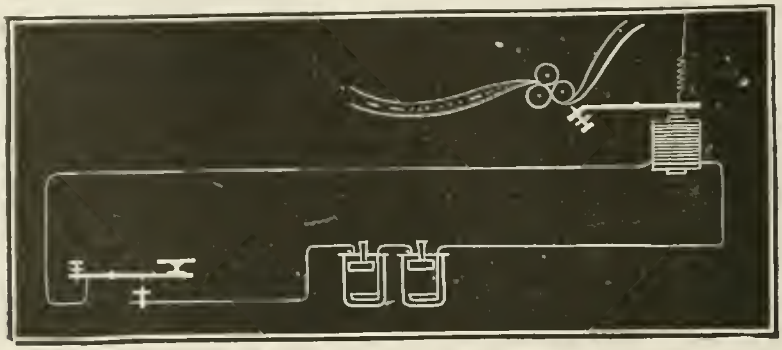


Fig. 3.

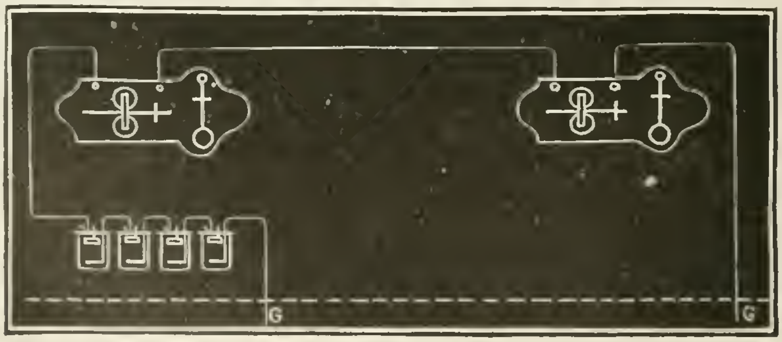
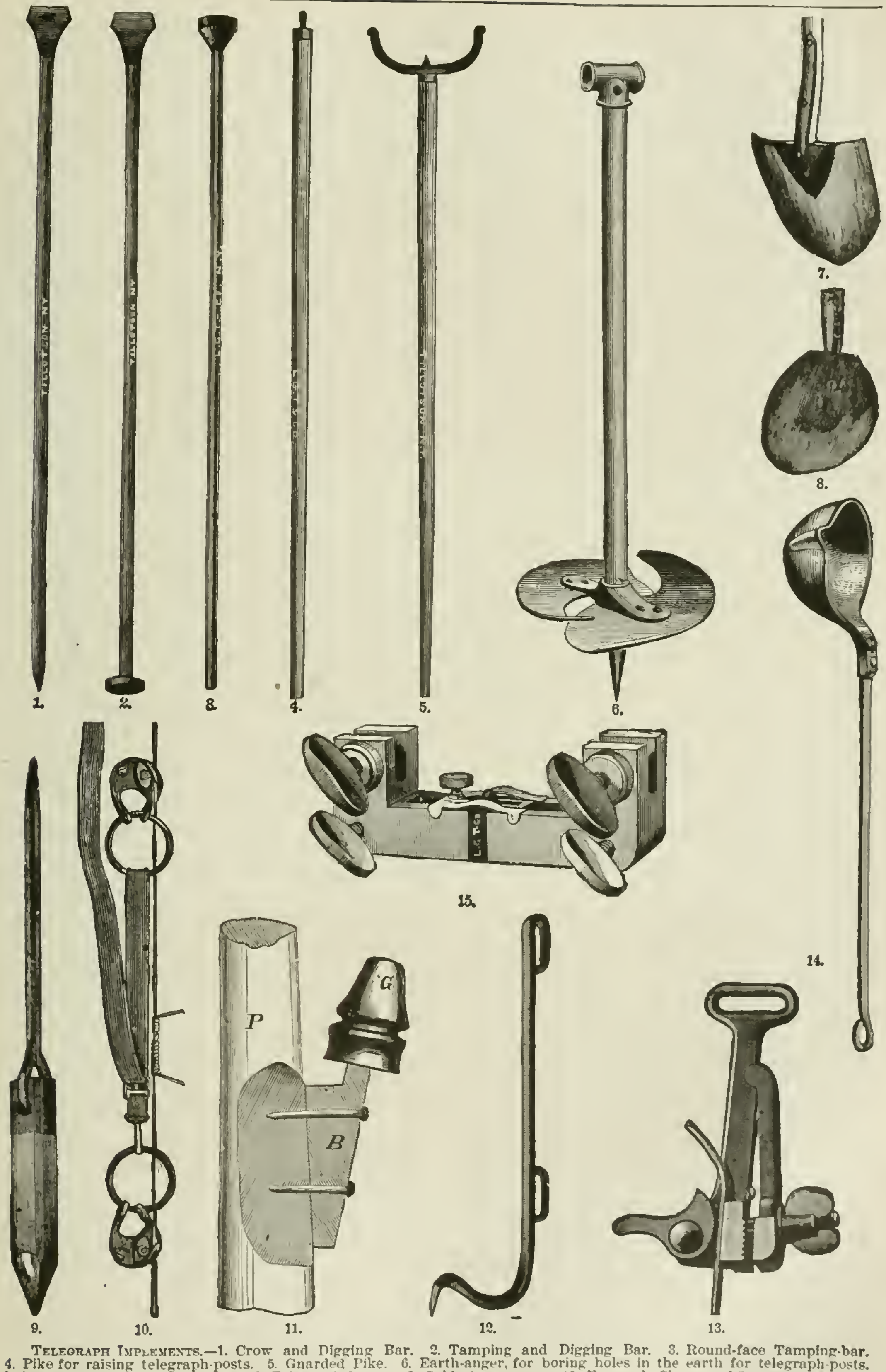


Fig. 4.



TELEGRAPH IMPLEMENTS.—1. Crow and Digging Bar. 2. Tamping and Digging Bar. 3. Round-face Tamping-bar. 4. Pike for raising telegraph-posts. 5. Guarded Pike. 6. Earth-auger, for boring holes in the earth for telegraph-posts. 7. Telegraph Shovel, round point. 8. Telegraph Spoon. 9. Soldering-copper. 10. Eccentric Clamp and Strap. 11. Section of glass insulator, and manner of attaching to pole; B is a bracket, spiked to the pole, P; over the upper part of the bracket fits the glass, G. 12. Climbers. 13. Brockton Combination Line-vise. 14. Solder-pot. 15. Line-tapping Clamp, for use in establishing Temporary Offices.

another separate and distant point. During the first years of telegraphy, the Morse register was the only means employed to put into tangible form the signals transmitted over the wires. See *Telegraph*. The armature of the magnet is attached to a lever, and this lever, which swings on a pivot in the middle, is provided at the end with a pointed pin or screw, which is caused to press upwards against a strip of paper whenever the magnet attracts, and to return to its former position when the reverse is the case. (Fig. 3.) Meanwhile the paper is kept moving steadily forward, so that if the lever-pin is pressed against the paper for only an instant of time a short mark or *dot* appears pressed or embossed into the paper. If for a longer time, the mark would be proportionately longer, or a *dash*. If alternately, the marks would come consecutively, and have *spaces* between them. As the Morse alphabet consists entirely of dots, dashes, spaces, and extra-long dashes, the letters and numerals are easily made with these marks and their combinations. So that as the hand of the operator, on the key at a distant point, makes short or long strokes, dots, or dashes, or spaces, these same marks appear on the paper as it comes from the register, and, being based on the formation given by the Morse alphabet, are as easily understood by the receiving operator as though they appeared in the well-known Roman characters. After the telegraph had been in successful operation for several years, the operators began to discover that, with practice, they could more easily distinguish the dots and dashes by the clicking sounds that came from the instrument, when the lever responded to the signals, than they could read them from the paper. This was the beginning of what is called *reading by sound*. At the present time none are considered good operators who cannot read by sound, and there are comparatively few registers employed in the United States.

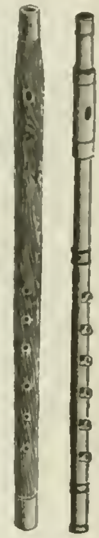
Having set up the battery, connect, as shown in the cut, one wire from the copper pole of the battery to one of the brass binding-posts of the instrument, and one wire from the zinc pole to the remaining binding-post; screw down the instrument firmly to the table with the screw in the base, as its best sound is thereby produced. See that none of the screws are loose in their places, and that the armature lever, which is the speaking tongue of the telegraph, plays freely, with a movement of about one sixteenth of an inch. The spring, which draws the armature-lever upwards, and is called the adjustment, should only be set at sufficient tension to raise the lever when no current is passing through the magnets. If drawn too tightly, the spring will not allow the armature to respond to the attractions of the magnet. When the instrument is not in use, leave the circuit-breaker of the key open so that the battery will not be in action, and its power accordingly economized. See that the platina points of the key are kept clean from dirt or dust, thus preventing imperfect contacts from being made. The key is provided with screws for the purpose of regulating its play to suit the hand of the operator, and to regulate also the pressure of the spring beneath it, for the same purpose. The best way to acquire the habit of correct Morse writing in the start is by practicing with another student at the same instrument, one at making letters, while the other by listening endeavors to name them. This is excellent practice for both; it is the beginning of sound-reading on the part of the one who names the letters, while the one who writes on the key *must* make the signals distinctly and correctly or they cannot possibly be distinguished by the other. Start rightly, and practice will soon make perfection of skill. No mental effort whatever is required of the practical operator to construct a Morse letter the moment his eyes come to it. And in transmitting messages he transmits the right signals in a continuous stream with as little effort or thought as the accomplished penman rapidly writes the words of a manuscript. The click of an instrument is as easily understood by a "sound-operator" who has had an experience of a year or two as his own language spoken in the clearest of accents. After two or three weeks of practice together over one instrument, two persons should be able to read each other's writing slowly, and should also have become familiar with the instruments, battery, and the principles of their operation. Separate practice over a short line between different rooms or buildings may then with advantage begin, each student having an instrument connected at his own end of the wire, and all communication between them necessarily being made by telegraph. According to the length of line between the two instruments, two or more cells of battery, arranged in series, will be required to operate in this way. Connect instruments and battery as shown in Fig. 4. The return-circuit may be made either by a continuous wire, as indicated, or by connection with the earth at each end, G G. For wires of but a short distance in length, the return-wire is best; for out-door lines of more than a few hundred feet in length use ground-wires, as earth-connections are called. To make a ground-wire, connect a wire to a plate or sheet of metal, zinc, iron, or tin; bury the latter in moist earth. The plate of metal should present not less than three square feet of surface. Gas and water pipes are, however, the best for this attachment, and whenever they are within reach should be used instead of buried plates in the earth. In running an out-door wire between points at any distance apart, it should be insulated (by using glass or rubber insulators) from all direct contact with buildings, posts, or trees. This prevents "escape" of the current, by which it would otherwise be diverted from its proper course through both of the instruments, and reaching the earth by a shorter route, would circulate to its opposite pole in the battery without having any effect whatever on the distant apparatus. To make a joint or splice in wire, brighten the ends by scraping them, and twist each wire around the other as closely and firmly as possible, so that no strain will draw them apart. In running wires inside of a building, use insulated copper wire covered either with cotton or gutta-percha; fasten it in place with small staples or tacks, but in doing so be careful not to allow the covering to be opened or stripped from the wire, nor to allow the latter to come in contact with gas or water pipes, or metal posts. In the beginning, when two persons are first practicing over a short wire, arranged as described, ordinary conversation carried on by telegraph is as good a means of practice, both at sending and at reading, as anything else. Then proceed with alternately sending printed matter from newspapers or books and copying it with a pen or pencil from the instrument by sound as the other sends it. As each improves, both in reading by sound and in sending plainly, this will become very pleasant and interesting occupation. The more important telegraph implements, as manufactured by Messrs. L. G. Tillotson and Company, the leading Government Contractors in America, are shown in the full-page engraving. See *Telegraph*.

FIELD-TRAIN.—A Department of the Royal Artillery, consisting of Commissaries and Conductors of Stores, responsible for the safe custody of the ammunition, for the formation of proper depots of shot, etc., between the front and the base of operations, and that a due proportion shall be constantly at the service of each gun during an engagement.

FIELD-WORKS.—Field-works may be enumerated under three heads. 1st. Those which, being secure on the flanks and in the rear, are assailable only in front. 2d. Those which are assailable in front and on the flanks. 3d. Those which are assailable on all sides. The plan of the works of the first class, when the front to be defended is of very limited extent, may be a simple *right line*. From this line only a front or direct fire can be brought to bear on the assailant in his advance, and when he attains the ditch, the fire of the parapet passing over his head, he is in a sheltered dead space where he can leisurely take his measures to assault the parapet. For extended fronts a flanked disposition more or less perfect can be obtained, from which cross as well as direct fire can be brought to bear on the advance of the assailant. The most simple combination for this object is the *crémaillère* or *serrated line*, which consists of a broken line formed of long and short branches perpendicular to each other. The salient angles are protected by a cross-fire, as well as a portion of the ditch in front of the salients; but the portion of the ditch at each re-entering angle is a dead-space, not being reached by the fire of the parapet. The plan of works of the second class admits of great variety, depending on the extent of the position. The most simple is that of a work of only two faces, the salient being towards the assailant's line of approach. This work is termed a *redan*. The faces should receive such direction as to sweep the approaches to the flanks of the position. As many pieces as possible are placed in the salient, and others disposed along the faces in the most commanding positions for sweeping the ground in their front. The angle formed at the salient by the faces should never be less than 60°. When the flank approaches extend somewhat to the rear, a flank is added to each face of the redan; it then becomes a *lunette*. The flanks receive such directions as will sweep by their fire that portion of the flank-approaches which cannot be reached from the faces except by a very oblique fire. The artillery is placed in position at the salients, in each of which is a pan-coupée. The works comprised in this class are termed inclosed works, as, being assailable on all sides, they must, for security, present a complete line throughout to any assault. These works may be divided into three orders: 1st. *Polygonal works*, or *redoubts*; 2d. *Tenailled works*, or *star-forts*; 3d. *Bastioned works*.

The defense of inclosed works demands that every point of the parapet should be guarded, at the moment of assault, either by cannon or musketry. The troops may be drawn up for the defense either in one, two, or three ranks; and there should, moreover, be a reserve proportioned to the importance attached to the work. The free interior space, denominated the *terre-plein*, or *parade*, should be sufficiently great to lodge the troops, with the cannon and its accessories, and will therefore depend on the nature of the defense. The following data will aid to regulate this point. Each man will occupy one yard, linear measure, along the interior crest, and each cannon from five to six yards. The space requisite to lodge each man is one and a half square yards; and about sixty square yards should be allowed for each gun. Besides this space an allowance must be made for the *traverses*, to cover an outlet, to screen the troops from a reverse or an enfilading fire, etc.; and for powder-magazines when they are not placed in the traverses. The area occupied by a traverse will depend on its dimensions, and cannot be fixed beforehand; that allowed for a magazine for three or four cannon may be estimated at fifteen or twenty square yards. As a field-fort must rely entirely on its own strength, it should be constructed with such care that the enemy will be forced to abandon an attempt to storm it, and be obliged to resort to the method of regular approaches used in the attack of permanent works. To effect this, all the ground around the fort, within the range of cannon, should offer no shelter to the enemy from its fire; the ditches should be flanked throughout; and the relief be so great as to preclude every attempt at scaling the work. See *Bastioned Forts*, *Field-fortification*, *Inclosed Works*, *Lunette*, *Priest-cap*, *Redan*, *Redoubt*, *Star-forts*, and *Swallow-tail*.

FIFE.—An ancient wind-instrument of military music, in which the melody is produced by blowing through a hole in a reed or tube, while the escape of air is regulated by the fingers stopping or opening a number of other holes in different parts of the pipe. It has a compass of two octaves, from D on the fourth line of the treble clef to D above in altissimo. The fife figures in the sculptured memorials of the Argonautic expedition, and from that time to this has maintained its place as a simple yet effective instrument for martial purposes. It was common with English troops till the reign of James I., but was then discontinued, to be reintroduced by the Duke of Cumberland at the siege of Maestricht in 1747. It is a universal favorite in the Navy, and many a stirring air on drums and fifes has cheered the sailor to deeds of daring.



FIFE MAJOR.—The chief or superintendent of the fifers of a regiment. In the English infantry there is a fifer to each company, and a Fife Major to each battalion, the former receiving the daily pay of 1*s*. 1*d*., the latter, who is a non-commissioned officer, 1*s*. 11*d*.

FIFER.—One who plays the fife. In the United States army there is one fifer allowed to each company of the infantry. Fifers are also employed aboard men-of-war and in the Marine Corps.

FIFTEEN-INCH GUN.—A smooth-bore, muzzle-loading cast-iron gun, mounted on a front- or center-pintle carriage, used in the United States sea-coast service. The following tables exhibit the principal weights, dimensions, and ranges of the gun:

DESIGNATION.	Lbs.	Inch.
Caliber	....	15
Weight	49,000	....
Preponderance	00	....
Length of piece	....	190
Length of bore (calibers)	....	....
Maximum diameter	....	48
Minimum diameter	....	25
Windage	....	0.13
Charge (mammoth or hexagonal powder) for shot	100	....
" for shell	60	....
Solid shot	450	....
Shell (unfilled)	330	....
Initial velocity (feet)	....	....
Weight of top-carriage	5,800	....
Weight of chassis	15,450	....
Carriage—wrought-iron (chassis with two air-cylinders to check recoil)	....	....

Ranges in Yards.

SHOT.		SHELL.			
Elevation.	Range.	Elevation.	Range.	Time of flight.	CHARGE.
Degs.	Yards.	Degs.	Yards.	Secs.	
1	769	1	600	1.44	100 lbs. of mammoth powder for solid shot, and 60 lbs. for shell.
2	1,332	2	1,073	2.79	
3	1,819	3	1,467	4.1	
4	2,235	4	1,800	5.28	To fill shell: 12 lbs. of mortar-powder.
5	2,601	5	2,094	6.44	
6	2,926	6	2,355	7.58	
7	3,221	7	2,590	8.67	Pressure per square inch, average 19,500 lbs.
8	3,491	8	2,804	9.68	
9	3,735	9	3,000	10.69	
10	3,959	10	3,171	11.63	Length of cartridge 100 lbs.=30 inches. 60 lbs.=18 inches.
15	4,890	15	3,916	16.30	
20	5,579	20	4,458	20.52	

The piece admits of 25 degrees elevation and 6 degrees depression. The platform is a permanent portion of the work. The top-carriage is the same; the chassis alone differs in the front-pintle and center-pintle carriages. The weight of the front-pintle chassis, including geared traverse-wheels is, 17,000 pounds. There are two kinds of geared traverse-wheels, differing however only in height and weight. The axis of the trunnions of the gun mounted on the higher is 8 feet 5.25 inches above the pintle-block, and 10 feet 11.25

inches above the terre-plein. Upon the other carriage it is 7 feet 2.25 inches above the pintle-block, and 9 feet 5.25 inches above the terre-plein. The front axle of the top-carriage is not eccentric; the rear one is. The front part of the sole of each shoe is cut away to a point a few inches in rear of the front axle, and to a depth of about half an inch. When the rear wheels are out of gear, the front wheels do not touch the chassis-rails; but when the rear wheels are thrown into gear, the rear part of the carriage is slightly raised, and the front part of the carriage is, in consequence of the soles being cut away, lowered; the front wheels then touch the chassis-rails and support the weight of the front part of the carriage, and the whole moves with rolling friction upon the front and rear truck-wheels. The wheels are out of gear when the gun is fired; the recoil is then on sliding friction. The front axle is furnished at each end with a brass sleeve, to which the counterpoise handspike is firmly attached. A pawl is attached to the handspike, and engages into ratchets in the truck-wheels. Bearing down upon the handspikes forces the wheels to turn, and communicates motion to the carriage. The handspike pawls are engaged in the ratchet of the truck-wheels only when it is desired to give motion to the carriage; at all other times they must be kept clear of the ratchets. To prevent the rear truck-wheels of the carriage from working out of gear while the gun is being run from battery, or jumping in gear when the gun is fired, pawls are provided for locking the rear axle. The elevation is given by means of the elevating arc. With a well-instructed detachment, the 15 inch gun can be fired twelve times in an hour, allowing time for deliberate pointing. The carriage and chassis for the front and center pintle have the same dimensions, viz.:

Length of chassis .... 19 feet 7 inches.
Width of chassis .... 5 feet 2 inches.
Depth of chassis-rail....... 1 foot 8 inches.
Length of carriage........ 8 feet 8 inches.
Inclination of chassis-rails. . 3 degrees.

See *Cast-iron Guns* and *Ordnance*.

FIGHT.—A struggle for victory, either between individuals or between armies, ships or navies. A duel is called a single fight or combat. A running fight is one in which the enemy is continually chased. To *fight it out* is to continue the contest until one side or the other gets the better. The French express it by *se battre à outrance*. See *Battle*.

FIGURE.—In fortification, the plan of any fortified place, or the interior polygon. Of this there are two sorts, regular and irregular. See *Field-works*.

FIGURE OF MERIT.—The figure denoting the efficiency of the shooting of a squad, a company, or battalion. The figure of merit is formed as follows: Average points obtained in the first and second periods. *The aggregate points to be divided by the number of men who commenced the first period.* Average points obtained in the volley-firing. Minus percentage of third-class shots at final classification.

Infantry.

	Very good.	Good.	Moderate.	When under.
Average points obtained in first and second periods together......	75	70	65	65
Average points obtained in volley-firing........	17	15	14	11
Percentage of third-class shots at final classification (*minus*).	8	12	16	When over. 16
Figure of merit	85	75	65	65
Average points in independent firing	18	16	15	15
Average points in the skirmishing....... ...	9	8	6	6

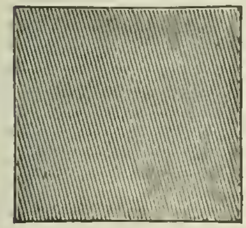
FILE.—1. File, in a military sense, is used to signify any line of men standing directly behind each other, as *rank* refers to men standing beside one another. In ordinary formations of the present day a battalion stands two deep, or in two ranks—front and rear—wherefore a file consists of two men. Sometimes, however, the battalion may be formed much more solidly, as in a square, when the file comprises a far larger number. The number of files in a company describes its width, as the number of ranks does its depth; thus, 100 men in "fours deep" would be spoken of as 25 files in 4 ranks.

2. The Ordnance Department employs one skilled file-cutter at the National Armory, who is kept constantly employed in recutting worn-out files and in making special files for certain classes of work required in the fabrication of small-arms. All the rotary files used in the establishment are also cut there. Since the introduction of "gun-steel" or Bessemer steel as the material for many of the components of arms, a good many files are used which are "new cut" or "skew cut." This "new" or "skew" cut is one in which the first course, or *over-cut*, is a light cut with small horizontal obliquity, while the second course, or *up-cut*, is coarser, with great horizontal obliquity. This method of cutting is excellent for a finishing-file, and is very popular among armorers on account of the ease of manipulation and freedom from clogging, as well as the smoothness of the surface produced. But, unless the quality of the milling be excellent, these files do not produce good results except with a great expenditure of time, a thing piece-workmen especially desire to avoid. Files are used upon surfaces of all kinds. Rasps are used upon those materials whose particles possess less resisting power, and are chiefly employed for rapid work. They are more used by workers in wood, soft metals, and leather than are files. The general effects of rubbing a file or rasp upon the surface of metal, wood, ivory, leather, or other material is to smooth it and change its form and dimensions. The abrasive effect consists in cutting from the surface small shavings or particles and in gradually reducing the mass. Therefore files are only used for shaping and smoothing small pieces, or in finishing surfaces that are already of approximate figure. The file usually follows the work of the lathe, the planer, the milling-machine, or the profiling-machine. In the natural motion of filing, the tendency is to impart to the file a somewhat circular motion, the articulation or joints of the arms and hands acting as centers of motion. It would seem that this kind of motion with a convex file should produce concavities in the work, whereas the real effect is to give a slight convexity to the work, due to the rocking motion caused by the work acting as a kind of fulcrum, except where the file is handled by a skillful manipulator. Every filer should aim to have his file, during the stroke, depart from a strait line just enough to bring it into contact with the desired portion of the work. The filing of round or curved surfaces requires that the strokes should be so blended as to produce the best effect. This class of filing depends a good deal upon the experience and eye of the workman, but is not so difficult as absolutely *flat* filing.

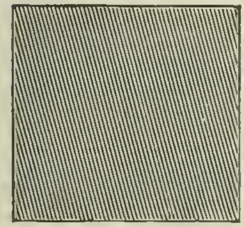
To the uninitiated the operation of filing seems to be a very simple matter, and one that can easily be attained by any person. On the contrary, the art of *filing well* is one which requires a great deal of skill and long-continued practice, as well as thought and judgment. It is true that in many shops there can be found filers who possess neither skill nor judgment, but who, from long practice on some special classes of work, have become known as filers. Such persons, however, are not, and do not deserve to be, called "good filers." It is also true that this same class of inferior workmen generally claim to be, and doubtless believe that they are, excellent filers. A rigid system of inspection and a persistency in pointing out the multitudinous defects of their "finished work" (so called) would result in instilling into their minds a belief that they were being persecuted, and

FLOAT CUT.

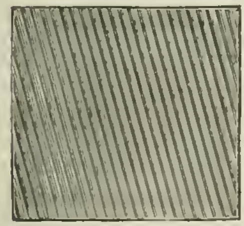
Dead Smooth.



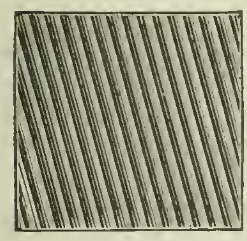
Smooth.



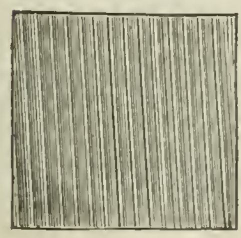
Second Cut.



Bastard.

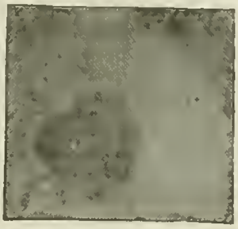


Float Rough.

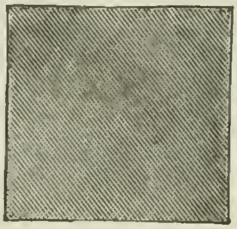


Bone Float.

DOUBLE CUT.



Dead Smooth.



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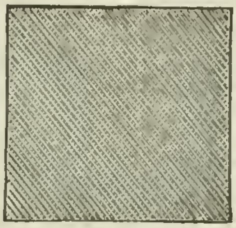

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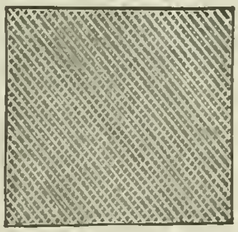

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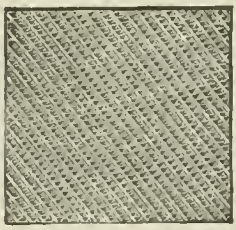
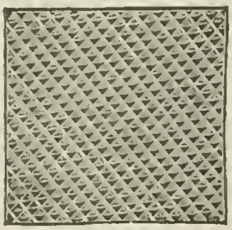
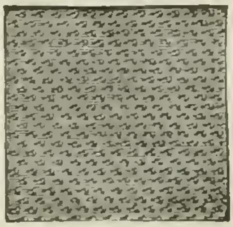


Middle Cut.

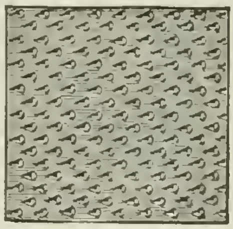


Rough.

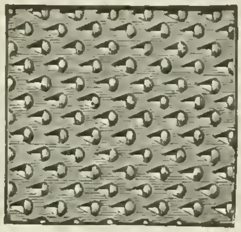
RASP CUT.



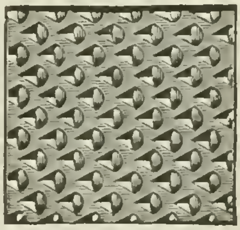
Smooth.



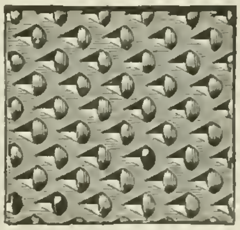
Second Cut.



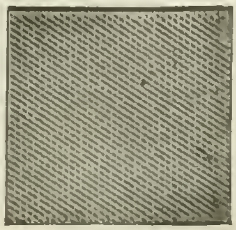
Bastard.



Middle Cut.



Rasp Rough.



New Cut.

that the Foreman or Superintendent was "down on them, and was seeking opportunity to find fault with their work." Very ignorant filers, as well as other classes of mechanics, artisans, and even professional men, are often as bigoted and self-conceited as they are unskillful and opinionated. With many of them it is an almost hopeless task to attempt to eradicate slovenliness in their manner of filing, especially after years of practice in such methods. Examples are numerous where men who have been filing for years do not even "know how to hold their files." Gun-makers, Master-mechanics, and Superintendents of manufacturing establishments where a great deal of filing is required, all know the difficulty of obtaining good filers. The supply is not equal to the demand, and the inequality increases yearly, and has done so since the practical abolition of the apprentice system in this country. The advent of planers, shaping-machines, trimming-machines, shaving-machines, and milling-machines has greatly diminished the amount of filing formerly required in the machine and gun shops; and filing, in its widest sense, is apparently about to be remanded to the category of the "lost arts." Boys and young men go to work on a machine, and find that in a few weeks or months they can earn fair pay without any previous study or apprenticeship; consequently it is not strange that they are loth to spend several years of apprenticeship in endeavoring to learn a trade which, when obtained, will bring little or no advance of a remuneration. Again, Proprietors of machine-shops are in such haste to get rich that they do not wish to employ any but skilled workmen, hence they refuse to be "bothered" with teaching boys who will probably leave their shops as soon as they have learned their trade. The old filers who have learned the trade regularly by a toilsome apprenticeship are gradually dying off, and no new brood is now being educated to supply their places. Hence the complaint is constantly heard that we cannot find enough good filers. How this evil is to be remedied is not within the province of this article, and the writers merely call attention to the fact.

There are very few mechanical operations that present greater difficulties than that of filing well. If a planer be used, the work is firmly fastened to the movable bed-plate, which has a motion of translation along fixed guide-rails, and passes under a tool attached to a tool-post with an automatic transverse feed-motion. If a shaper be employed, the work is keyed to the immovable bed and the tool has a motion of translation and rotation, the former governed by fixed guides and the latter by a screw. In neither of the cases above cited does the accuracy of the work depend upon the workman's skill after the machine has been set and put in motion. But in filing, the "guiding principle" of the machine is absent, and the accuracy of the work depends upon the constant care, skill, and judgment of the man. To produce a "*true flat surface*" upon narrow work is an excellent test in filing. One would naturally suppose that a file the points of whose teeth lie in the surface of a single plane is all that is required to do the work. Even if the *side* of the file was a *perfectly* plane surface—which it never is—it would be necessary to move it in parallel straight lines across the work to produce the required effect. Supposing this operation possible, the pressure applied at the ends of the file, as is usual, would spring the file and produce a concavity on its under surface, which in turn would naturally round the work. To obviate this defect the file should have its sides slightly convex. The greater the convexity of the file the fewer teeth that come in contact with the surface and the better will the file cut or bite, provided the pressure remains constant. The convexity is sometimes given by slightly curving or tapering the sides from about the middle to the point. A better way, perhaps, is to have the gradual curvature extend from the heel to the point. The advantages of the convexity are plainly seen when the attempt is made to produce an approximately true plane surface. The straight-edge or surface-plate will show the points on the surface, which are a little higher than the rest, and without a file with convexity it is impossible to touch the exact spot desired and no other. The full-page engraving represents the New American File Company's cuts of files and rasps. This Company use the Bernot machines for cutting, and the accuracy and uniformity of cut in all their product is unequaled by that produced by any other methods, either by hand or otherwise. See *Rasp.*

FILE LEADER.—The soldier placed in front of any file, or the man who is to cover all those who stand directly in the rear of him, and by whom they are to be guided in all their movements.

FILEY SYSTEM OF FORTIFICATION.—In this system the curtain is replaced by a bastion or mezalectre, whose flanks defend the collateral works. There are cavaliers on the curtains, retrenchments in the bastions, tenailles between the bastions and mezalectre, ravelins, counter-guards, and covered-way. The great defect of this system is that the enemy can attack the mezalectre instead of the bastions

FILIBEG—FILLIBEG.—A little plaid; a kilt or a dress reaching nearly to the knees, worn in the Highlands of Scotland, and by the soldiers of Highland regiments in the British service.

FILIBUSTERS—FILLIBUSTERS.—Another name for piratical adventurers. Recently it has become familiar to English ears as the designation of certain lawless adventurers belonging to the United States, who have attempted violently to possess themselves of various countries in North America. The plea urged by these persons has generally been that such countries were a prey to anarchy and oppression, and could only attain to prosperity by annexation to the United States, and the introduction of democratic institutions—among which, strange to say, slavery stands prominent. The most notorious of these filibusters was the late William Walker, whose expedition against Nicaragua in 1855 was so far successful that he kept his ground in that country for nearly two years. At last he was driven out by a combination of the various States of Central America. He was subsequently captured and shot, September 12, 1860, at Truxillo, in Central America, in the course of another piratical expedition.

FILINGS.—In tactics, the numerous movements to the front, to the rear, or to the flanks, by files.

FILLET.—1. A molding used on cannon of old form. 2. In Heraldry, an ordinary which, according to Guillim, contains the fourth part of the chief. 3. A head-covering that frequently replaced the helmet among the Assyrio-Babylonian archers.

FIMBRIATED.—A term in Heraldry, said of any ordinary having a narrow border or edging of another tincture.

FINAL VELOCITY.—In gunnery, the technical term for the uniform velocity which a projectile would acquire in falling through an indefinite height in the air. A body falling in *vacuo* is uniformly accelerated, its velocity being continually increased. In the atmosphere the case is different. Since the resistance of the air increases with some power of the velocity greater than the square, it follows that at some point in the descent the retardation becomes equal to the acceleration, and the body will move with uniform velocity. This is called *final velocity*, and is one of the most important elements in the theory of projectiles. Other things being equal, that projectile is best which has the greatest final velocity. See *Form of Projectile*, *Projectiles*, and *Velocity*.

FINDING.—Before a Court-Martial deliberates upon the judgment, the Judge Advocate reads over the whole proceedings of the Court; he then collects the votes of each member, beginning with the youngest. The best mode of doing so is by slips of paper. The Articles of War require a majority in all cases, and in case of sentence of death two thirds. It is not necessary to find a *general* verdict of guilt or acquittal upon the whole of every charge. The Court may find a prisoner guilty of part of a charge, and acquit him of the remainder, and render sentence according to their finding. This is a *special* verdict.

FINING-FORGE.—An open hearth with a blast by which iron is freed of impurities or foreign matters. Cast-iron is thus rendered malleable by the removal of carbon, etc.

FINISHING.—The final operation in the fabrication of cast guns. When the casting has become cool it is hoisted out from the pit, the flask being first taken off. The molding composition adhering to the interior or exterior is removed as far as practicable by scrapers and chisels. The casting is then placed in a machine called a heading-lathe, shown in Fig. 1, where the greater part of the surplus metal of the chase is removed and the sinking-head is cut off. From the latter a ring is also cut off next to the muzzle of the gun for the purpose of testing the initial strain, and from which specimens are afterwards taken for tenacity and density. To place the gun in the lathe, the square knob of the cascabel is fitted into the chuck attached to the machinery, which revolves the gun, while the sinking-head is introduced into the "bonnet" which revolves in its bearing at the other extremity of the lathe. Both of these supports are provided with adjustable screws by means of which the gun is centered from the bore, as it sometimes happens that the axis of the bore and casting do not coincide. The gun being centered, all the measurements necessary for a proper commencement of the turning are made.

The turning of the gun commences near the muzzle. The rest in which the turning-tool is placed is so constructed that it can be moved either parallel to or at right angles to the axis of the gun. The tool is brought in contact with the surface of the gun at the desired point, the metal being turned off as the gun revolves. In this way a series of narrow cuts are made in the chase at short intervals, extending in depth to within about two inches of the required exterior diameter of the gun. The intervening rings are then broken out with wedges, and the portion of the chase next the muzzle is turned down to the finished dimensions. Meanwhile the cylindrical part of the cascabel is turned down slightly to form, with the finished part of the chase, bearings for the gun when transferred to the boring-lathe. The cuts at the muzzle for removing the sinking-head and test-ring are next made. When these cuts have reached a sufficient depth to admit of the separation, the gun is taken out of the lathe and placed upon skids and the bonnet is removed from the sinking-head. The ring and head together are

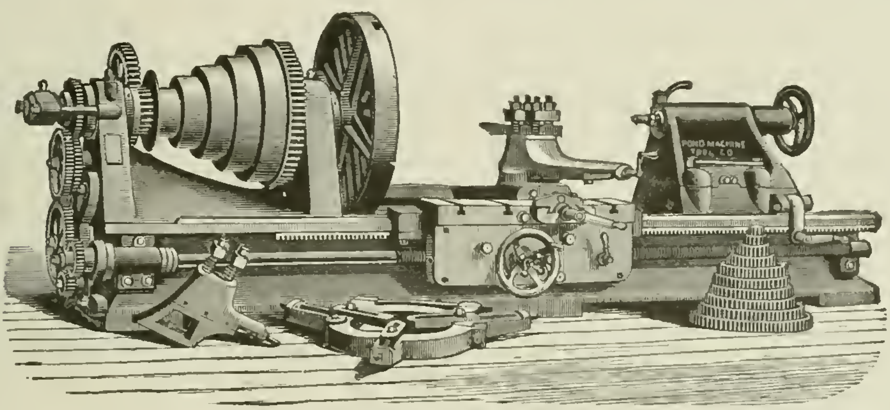


Fig. 1.

tered and held firmly in place. The breech is adjusted by placing a sharp-pointed instrument in the tool-rest and bringing it in contact with the surface of the casting near the maximum diameter, and, while turning the gun, the screws in the chuck are moved until coincidence of the line around the gun is obtained. At the muzzle a bar of iron is laid upon blocks so that it shall be just inside the bore and nearly in contact with the interior surface. As the gun turns, the distance between this point and the metal of the bore is observed and equalized approximately by the screws in the bonnet.

A wooden disk, turned to fit the bore accurately, bearing a string attached to its center, is then pushed to the bottom of the bore and made to assume a position in a plane perpendicular to its axis. The string from the center of the disk is long enough to reach some distance outside the muzzle, the outer end being made fast to an upright at the same height as the inner end or center of the disk. The string is now stretched perfectly taut and the gun again turned, a square being placed upon blocks about one foot in front of the muzzle close to the string, and, as the gun revolves, the distance, if any, which the string deviates from the square is observed and corrected by again moving the screws in the bonnet. When properly centered, the string will remain in the same position in the square and be the same distance from the interior surface of the gun throughout an entire revolution, showing that the axes of the gun and lathe coincide. With the hollow-cast gun it is necessary that it should then separated from the gun by inserting wedges at the muzzle, and the ring is afterwards wedged off from the head. The gun is next placed in the boring-lathe, in which it is supported by bearings at the chase and neck of cascabel. Its rotation in the lathe is effected by securing the square knob of the cascabel in the chuck attached to the revolving machinery, in the same manner as in the heading-lathe.

To adjust the gun the boring-rod is first introduced a short distance into the bore, and the space between its exterior surfaces and the gun at the muzzle is observed. For this purpose a thin wooden gauge is used, pointed at one end and having a notch at the other, which takes the outer surface of the gun at the muzzle —the gauge being laid on the face of the muzzle and therefore perpendicular to the axis of the bore. As the gun revolves the distance above, below, and on either side is observed, verifying the concentricity of the axis of the gun at the muzzle. The adjustment is completed at the breech by slackening the bolts of the cascabel bearing, leaving it free to move on the ways; and should any lateral motion be perceptible, it is corrected by adjusting the screws in the chuck, after which the concentricity is complete from breech to muzzle.

In boring, the tools or cutters are fitted into a cylindrical block called a "head," which is secured to the end of the boring-rod. As the gun revolves in the lathe, the boring-rod is made to advance by machinery until the cutters reach the bottom of the cylindrical part of the bore. From three to five cuts are usually required to secure a perfectly straight bore and enlarge it to its required diameter; the last one being made with a finishing-tool or reamer. The bottom of the bore is then finished with tools of the required shape.

During the process of boring the turning continues, and the exterior is finished except the trunnion section and the extremity of the breech where the cascabel attaches. The cascabel is turned down in front of the bearing so that it can be broken off when no longer required. To insure a smooth surface in the bore, the work upon the exterior of the gun is suspended while the finishing tools are being used.

The boring being completed, the dimensions of the bore of the gun are verified before removing it from the lathe. If found to be correct, the gun is removed and placed in the trunnion-lathe, where the trunnions are turned down to the finished dimensions. When adjusted in this lathe the axis of the gun is in a horizontal plane, the cascabel being supported by the breech-center, and the chase by the muzzle-bearing. The trunnion-head consists of a hollow shaft in which are located the cutters for turning the trunnions. It is supported upon bearings which rest upon ways at right angles to the axis of the gun. These bearings are of such a height as to bring the axes of the trunnion-head and gun in the same horizontal plane.

In turning the trunnions the gun remains stationary while the trunnion-head revolves about the trunnion. The cylindrical surface is first finished, the shaft moving towards the gun and its speed being regulated as circumstances require. To finish the face a broad cutter is used which removes a thin chip nearly equal in width to the semi-diameter of the trunnion. A small spur is left by this tool at the center of the trunnion which is afterward chipped off by hand. When one trunnion is finished, the gun is turned over and the other is finished in the same manner.

The metal in excess between the trunnions is removed by the planing-machine (Fig. 2), which is placed on the side of the lathe opposite the trunnion-head. This machine is so arranged that the bar in which the cutter is secured moves forward and back in a horizontal plane, carrying the cutter over that portion of the gun between the trunnions which has not been turned down. The cutter works upon a pivot in the bar, by means of which it cuts only while moving to the rear, the gun being turned the width of the cut after each passage of the planing-bar. The proper direction is given to the cutter by means of a guide attached to the planing-bar which moves in a groove of the required curvature.

After the planing is finished, the gun is removed

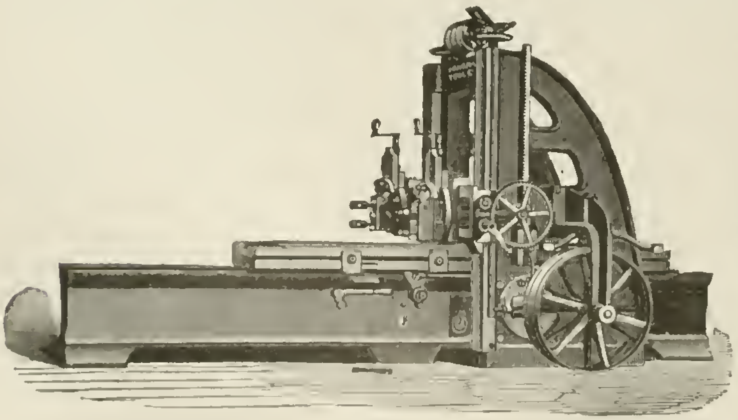
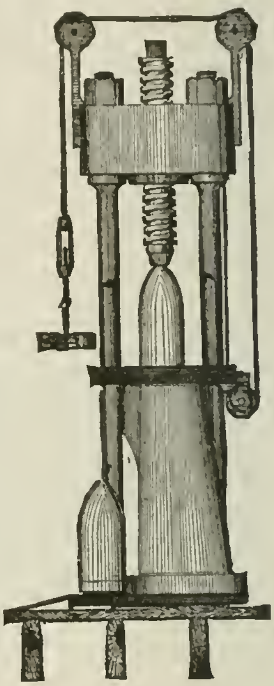


Fig. 2.

from the lathe, placed upon skids, and the cascabel is broken off. The breech, rimbases, and sight-mass are then finished by chipping off the surplus metal by hand. The vent is usually drilled by means of a hand drill arranged to work in an iron frame firmly secured to the gun. See *Lathe, Ordnance, Rodman Gun*, and *Turning*.

FINISHING PRESS.—This machine, employed in the fabrication of projectiles, as shown in the drawing, consists of a steel die, supported on a hollow iron platform resting upon the head of an hydraulic ram which is worked by a steam pump. On the left of the press is a handle for opening the valve to allow the admission of the water to the cylinder, and an automatic device for closing it and opening the valve for the escape, when the ram has reached its proper stroke. There are four iron guides for the hollow platform, connected at the top by an iron cross-head, through the center of which passes a heavy screw; the end of the screw is hollowed out to the shape of the head of the shot, for which it forms a support. Iron tongs are used for raising the shot from the floor to its seat, and these are raised and lowered by the movement of the machine itself. Two workmen are required for the machine, and two cuts are taken on each shot; the smaller die being the true size of the shot, and the other slightly larger. Supposing one shot to have been fitted into the die for the short length turned down in the lathe and its head inserted in the end of the screw, another is stood upright on the floor. One workman quickly opens the valve, while the other guides the descending tongs over the head of the shot below, as the hollow platform and die move upward. When the tongs have reached the center of the shot below they are clamped. As soon as the die has passed over the cylindrical part of the shot, the latter falls through the hollow platform into sawdust below; the automatic device then releases the ram, which descends,



and raises the tongs with the shot which is attached, and which is guided into its seat by the workmen. With this machine a thousand shot can be turned out per day. The dies, which are made of American steel, will last for about 1000 shot without resetting. The same operation is oftentimes performed in part or entirely in the lathe, but is very much less rapid than that just described. See *Fabrication of Projectiles*.

FIRE.—1. Artillery-fires are distinguished by the manner in which the projectile strikes the object, as *direct*, *ricochet*, *rolling*, and *plunging* fires; by the nature of the projectile, as *solid shot*, *shell*, *shrapnel*, *grape*, and *canister* fires; and by the angle of elevation, as *horizontal fire*, or the fire of guns and howitzers under low angles of elevation, and *vertical* fires, or the fire of mortars under high angles of elevation. A fire is said to be *direct* when the projectile hits its object before striking any intermediate object, as the surface of the ground, or water. This species of fire is employed where great penetration is required, as the force of the projectile is not diminished by previous impact; it is necessarily employed for spherical-case shot, and for rifle-cannon projectiles, which, from their form, are liable to be deflected by previously striking a resisting substance; it is also used for all field-cannon projectiles, when the nature of the ground does not insure a regular rebound. To point a piece in direct fire, bring the line of sight to bear upon the object, and then elevate the piece according to the distance. When a projectile strikes the ground or water under a small angle or fall, it penetrates obliquely to a certain distance, and is then reflected at an angle greater than the angle of fall; the reason for this is that the projectile in forming the furrow loses a portion of its velocity, making the distance from A (Fig. 1), the point at which it enters the ground, to C, or the vertical drawn through the deepest point, greater than the distance from C to D, the point where it leaves the ground. As this recurs every time the projectile strikes the ground, it follows that the trajectory is made up of a series of rebounds, or *ricochets*, each one shorter and more curved than the preceding one. The number, shape, and extent of the ricochets depend on the nature of the surface struck, the initial velocity, shape, size, and density of the projectile, and on the angle of fall. A spherical projectile ricochets well on smooth water, when the angle of fall is less than 8°; but if the surface of the water be rough very little dependence can be placed on the extent of the ricochet. In general, those projectiles which present a uniform surface and have the least penetrating power are most suitable for ricochet-firing; hence large shells fired with small charges are more suitable than solid shot, and round projectiles more suitable than those of an oblong form. The distance at which the larger-size shells will ricochet on water is about 3000 yards, the axis of the piece being horizontal and near the water. Ricochet-fire is employed in siege-operations to attain the face of a work in flank, or in reverse (Fig. 2), and on the field or on water when the object is large and its distance is not accurately known. The character of ricochet-fire is determined by the angle of fall, or the angle included between the tangent of the trajectory and horizon at the point of fall. There are two kinds of ricochet-fire—the *flattened*, in which the angle of fall is between 2° and 4°; and the *curvated*, in which the angle of fall is between 6° and 15°. The principal pieces employed in ricochet-fire in siege operations are the 8-inch howitzer and the 8- and 10-inch common mortars; the first two may be used when the angle of fall is less than 10°, and the 10-inch mortar when the angle of fall is less than 15°. With these pieces the limit of ricochet is about 600 yards. Solid shot should not be used in ricochet fire for any distance less than 200 yards, as it would then be necessary to diminish its velocity so much as to destroy its percussive effect. In ricochet-firing against troops in the open field the angle of fall should not exceed 3°. In enfilading the face of a work, the form of the trajectory and point of fall should be such that the projectile will strike the surface of the terre-plein the greatest number of times; the object being to destroy the men, carriages, and traverses situated upon it. To do this the projectile should be made to graze the crest of the adjacent parapet, and strike the terre-plein as near the foot of the interior slope as possible; the distance of the crest, and its height above the terre-plein and battery, should therefore be known.

Rolling fire is a particular case of ricochet-fire, produced by placing the axis of the piece parallel, or neary so, with the ground. It is generally used in field service. When the ground is favorable for ricochet, the projectile, in rolling fire, has a very long range, and never passes at a greater distance above the ground than the muzzle of the piece; it is therefore more effective than direct fire, as may be seen by inspecting Fig. 3. To point a piece in rolling fire, direct it at the object, and depress the natural line of sight so as to pierce the surface of the ground about 80 yards in front of the muzzle; if the piece be sighted for the pendulum hausse, aim directly at the object with the lowest line of sight, or with the slider fixed at the zero-point of the scale. A fire is said to be *plunging* when the object is situated below the piece. This fire is particularly effective against the decks of vessels.

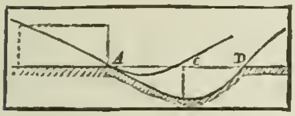


Fig. 1.

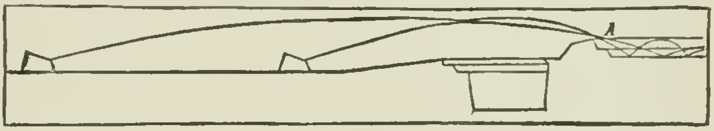


Fig. 2.

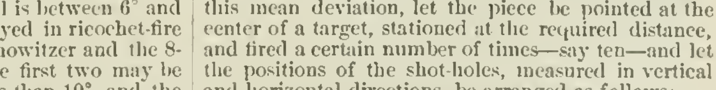


Fig. 3.

Before proceeding to describe the fires of different kinds of projectiles, it may be proper to explain what is meant by accuracy of fire, and to determine a suitable measure for it. It has been seen that there are causes constantly at work to deviate nearly every projectile from its true path. As the effect of these deviating forces cannot be accurately foretold, there is only a probability that the projectile will strike the object against which the piece is pointed. The degree of probability is called accuracy of fire. For all projectiles of the same nature, the chance of hitting an object increases with the velocity and weight of the projectile, whereby the effects of the deviating forces are diminished; it also increases as the size of the object is equal to, or greater than, the mean deviations, and as the trajectory more nearly coincides with the line of sight. If the size of the object be greater than the extreme deviation, and the trajectory coincide with the line of sight, the projectile will be certain to hit the object at all distances. For the same trajectory, therefore, the mean deviation of a projectile at a given distance may be taken as an indirect measure of its accuracy at this distance. To obtain this mean deviation, let the piece be pointed at the center of a target, stationed at the required distance, and fired a certain number of times—say ten—and let the positions of the shot-holes, measured in vertical and horizontal directions, be arranged as follows:

No. of Shot	Distances from Center of Target, in Feet.				Distances from Center of Impact, in Feet.			
	Vertical.		Horizontal.		Vertical.		Horizontal.	
	Above.	Below.	Right.	Left.	Above.	Below.	Right.	Left.
1	3		4		4.33		2.66	
2		6		2		4.66		3.33
3		1	2		.33		.66	
	3	7	6	2	4.66	4.66	3.33	3.33
	4 + 3 = 1 33		4 + 3 = 1.33		9.32 + 3 = 3.11		6.66+3=2.22	

The algebraic sum of the distances in each direction, divided by the number of shots, gives the position of the center of impact in this direction. In the above table the position of the center of impact is found to be 1.33 feet below, and 1.33 feet to the right, of the center of the target. To obtain the mean deviation, it is necessary to refer each shot-hole to the center of impact as a new origin of co-ordinates; and this is done by subtracting the tabular distance from the distance of the center of impact if both be on the same side of the center of the target, and adding them if on different sides. The sum of all the distances thus obtained in one direction, divided by the number of shots, gives the mean deviation in that direction; which in the present case is 3.11 feet vertically and 2.22 horizontally. The vertical deviation of a projectile is generally greater than its corresponding horizontal deviation, and this difference increases with the range. As objects against which military projectiles are directed present a greater extent of surface in a horizontal than in a vertical direction, it becomes necessary to exercise great care in the selection of the proper angle of fire. If the ground or water in front of the object be favorable to ricochet, the difficulty will be diminished by aiming so that the projectile will strike the object after one or more rebounds.

Solid shot are generally used for percussion and penetration, and, when heated to a red heat, for the purpose of setting fire to wooden vessels or buildings. From their great strength, they can be fired with a large charge of powder, which gives them great initial velocity, and having great density, which diminishes the effect of the resistance of the air, they have great range and accuracy. In firing hot shot, the charge should be reduced, to prevent too great penetration, which would exclude the air and render combustion impossible. The extreme range of field-artillery is about 3000 yards; it is not very effective, however, beyond 1700 yards for the 6-pounder and 2100 yards for the 12-pounder. At 600 yards the horizontal deviation of the 12-pounder is about 3 feet, and at 1200 yards it is about 12 feet. For the 6-pounder the deviations are somewhat greater at both distances. The service of solid shot demands less skill than that of shells and spherical case-shot, and they are often effective when the latter are rendered non-effective by untimely explosion.

The diameter and velocity of two projectiles being the same, the retarding effect of the air is inversely proportional to their weight; hence we see that a shell has less accuracy and range than a solid shot of the same size, in the proportion of 3 to 2—these numbers representing the weights of a solid shot and shell respectively. As shells act both by percussion and explosion, they are particularly effective against animate objects, earthworks, buildings, block-houses and shipping, posts and villages occupied by troops, and against troops sheltered by accidents of the ground; but against good masonry they have but little effect, as they break on striking. Against troops, especially cavalry, they possess a certain moral effect which solid shot do not possess. They are used to form breaches in intrenchments, in which case they act as small mines. The 32-pounder shell is the most effective field-projectile for this purpose; and, when fired with a large charge, has a penetration of from 5 to 8 feet in fresh earth.

The extreme range of field-shells is from 2500 to 3000 yards. The 24-and 32-pounder shells burst into about eighteen effective fragments, some of which are thrown to a distance of 600 yards. All field-shells have considerable lateral deviation; it is stated that the 24-pounder shell is sometimes deviated as much as 30 yards in 1200. The extreme range of the mountain-howitzer is about 1200 yards, after three or four rebounds. The 12-pounder shell employed in this service bursts into twelve or fifteen fragments, some of which are thrown to a distance of 300 yards. The great weight of an 8-inch shell, and the large quantity of powder which it contains, render it a very formidable projectile against the traverses and epaulements of siege-works. In sea-coast defense, the 8-, 10-, and 15-inch shells are very destructive to vessels built of timber. They range from 3 to 3½ miles; but the angle which the trajectory makes with the line of sight at this distance (about 40°) renders their fire very uncertain against individual objects of the size of a ship: but it is presumed that they would have the effect to prevent a blockading fleet from lying at anchor within their range, as it is well known that a single 10-inch shell, striking on the deck of a vessel, has sufficient force to penetrate to the bottom and sink her. The 8-inch shell bursts into 28 or 30 fragments; and from the experiments made at Brest, some years ago, it was inferred that three or four of these shells, properly timed and directed, were capable of disabling a ship of war.

Mortar-shells are employed to break through the roofs of magazines, etc., and to blow them up; to destroy the surface of the terre-pleins, ditches, etc., by forming deep hollows, which are produced by explosion, and to interrupt the communications from one part of a work to another. The great depth to which mortar-shells penetrate in earth almost entirely destroys the effect of their fragments; some remain buried in the ground, and the others are thrown out at too high an angle to be dangerous. One of the principal objects of traverses, on a terre-plein, is to confine the bursting-effects of shells within narrow limits. Mortar-shells penetrate from half a yard to one yard in earth; and the amount of earth thrown up by explosion is about one cubic yard for each pound of the bursting-charge. Ordinarily the diameter of the crater at the top is two or three times the depth. The 13-inch shell will often break in falling on a pavement. Roofs of good masonry, little more than a yard thick, are sufficient to resist the penetration of mortar-shells. The effect of mortar-firing is generally in favor of the besiegers, as the works of the besieged present a larger and more favorable surface for the action of shells. The charge of a stone mortar should be small, to prevent the stones and grenades from being too much scattered. A charge of stones is generally scattered over a space varying from 30 to 50 yards broad, and from 60 to 100 yards long. The dispersion of grenades is somewhat less than this; the larger portion, however, are found within a radius of 12 or 15 yards.

When a shrapnel or case-shot bursts in its flight, the fragments of the case and the contained projectiles are influenced by two forces, viz., the force of propulsion, which moves each piece in the direction of the trajectory, and the force of rupture, which moves it in the direction of a normal to the surface of the case. The path described by each fragment and projectile depends on the angle which the normal makes with the trajectory, and on the relative velocities generated by the two forces; and, when taken together, these paths form a species of cone, called the

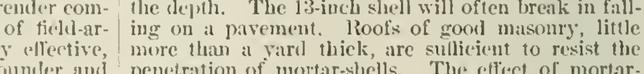


FIG. 4.

cone of dispersion, the apex of which coincides with the point of rupture, and the axis is the trajectory, prolonged. (Fig. 4.) The velocity of a projectile diminishes from the time it leaves its piece, while the velocity generated by the rupturing force remains constant. It follows, therefore, that the dispersion of a spherical case-shot increases with the distance, while the force of impact is diminished. The distance at which a spherical case-shot ceases to be effective depends on the relation between the remaining velocity and the velocity generated by the force of rupture. The improvements which have lately been introduced into this species of projectile have for their objects to increase the remaining velocity at any point by increasing the propelling charge, and to diminish the force of rupture, and at the same time increase the number of contained projectiles, by diminishing the bursting-charge. By filling the interstices of the bullets with sulphur or rosin, the propelling charge of a spherical case-shot can be made the same as that of a solid shot.

It is considered that a spherical case-shot is effective when a large portion of the projectiles have sufficient force to penetrate 1 inch of soft pine. The present 12-pounder spherical case-shot, fired with a charge of 2½ pounds of powder, has a remaining velocity of about 500 feet at a distance of 1500 yards, which renders it effective at this distance. The principal difficulty experienced in firing a spherical case-shot is to burst it at the proper distance in front of the object. This arises from the difficulty of estimating the correct distance of the object, the rapid flight of the projectile, and the difficulty of observing the effect of a shot in order that correction may be made for the succeeding one if necessary. To overcome these difficulties requires skill and judgment on the part of the gunner, and great accuracy and delicacy in the operation of the fuse. The proper position of the point of rupture varies from 50 to 130 yards in front of, and from 15 to 20 feet above, the object. The weight of a spherical case-shot is about the same as a solid shot of the same size, and, being fired with the same charge of powder, it can be used for attaining long ranges in the absence of solid shot. For this purpose the fuse should not be cut. Spherical case-shot should not be used for a less distance than 500 yards; although in cases of emergency the fuse may be cut so short that the projectile will burst at the muzzle of the piece, in which case it will act like grape or canister shot.

In grape and canister firing, the apex of the cone of dispersion is situated in the muzzle of the piece, and the destructive effect is confined to short distances. The shape of this cone is the same as in spherical case-shot; its intersection by a vertical plane is circular, while that of a horizontal plane, as the ground, is an oval, with its greatest diameter in the plane of fire. The greatest number of projectiles are found around the axis of the cone, while the extreme deviations amount to nearly one tenth of the range. The most suitable distance for field canister-shot is from 350 to 500 yards; if the ground be hard and the surface be uniform, the effect may extend as far as 800 yards. In cases of great emergency a double charge of canister, fired with a single cartridge, may be used for distances between 150 and 200 yards. Under favorable circumstances, one third of the whole number of contained projectiles will strike the size of a half-battalion front of infantry, and one half the front of a squadron of cavalry. Grape and canister shot are employed in siege and sea-coast operations; in the latter they are effective against boats and the rigging, etc., of vessels. Grape-shot, being larger than canister-shot, are effective at greater distances. Canister-shot for the mountain-service are not effective beyond 250 and 300 yards.

Beyond 200 yards the fire of the smooth-bored musket becomes very uncertain against individual objects, as the lateral deviations often exceed four feet; but by aiming high it may be made effective against troops in mass at 400 yards. The fire of the rifle-musket is effective at 1000 yards; the angle of fall, however, is so great (about 5°) that great care must be exercised in determining the exact distance of the object. If the ground be favorable, the projectile will ricochet at 1000 yards, which increases the *dangerous space*, and therefore the chances of hitting the object. The limit of any fire is determined by the distinctness of vision. The limit of distinct vision for a foot-soldier is about 1100 yards; that for a mounted soldier is about 1300 yards. The effect of small-arm firing depends much on the skill and self-possession of the soldier in action, for without these qualities the most powerful and accurate arms will be of little avail. The number of cartridges expended for each person disabled in previous European wars has been variously stated to be from 3000 to 10,000. In the late Mexican war, where an unusually large proportion of the American troops were armed with rifles, this number has been estimated to be from 300 to 400. Where a soldier discharges his piece from the back of a horse, as in the cavalry service, the effect of fire is much less than in the dragoon and mounted-rifle services, where he rides from point to point, but discharges his piece on foot. At short distances, and against troops in mass, two or three round bullets may be employed with good effect. See *Cannon*, *Firing* and *Pointing*.

2. Whether a tribe of men ignorant of fire and its uses has ever existed, is a question in dispute among historians and travelers. It will be enough to say that absolute proof of the existence of such a tribe has not been presented, though there are many well-authenticated facts and circumstances that suggest its possibility. The uses and dangers of fire, and to a certain extent the means of controlling it, must have been generally understood at a very early age. At first it may have been simply an object of terror, but probably men soon discovered that it was a friend no less than an enemy. Concussion or friction was undoubtedly the earliest method employed for producing fire. In the process of chipping stone, sparks were elicited, which, falling upon combustible substances, may have taught men how to produce a blaze at pleasure. The concussion of flint and steel was for ages doubtless the common method of kindling a fire, and it has not yet been entirely superseded. The Alaskans strike together two pieces of quartz, rubbed with sulphur, thereby setting the sulphur on fire, and then transfer the flame to a heap of dry grass. The Esquimaux use quartz and iron pyrites. In some countries sparks are produced by striking a piece of broken china upon bamboo; in Cochin China two pieces of bamboo are used, the silicious character of the outside layer of this wood rendering it as good as native flint. Numerous mechanical devices for increasing by rapidity of motion the friction of different woods were resorted to. In some cases a stick was rubbed backward and forward; in others it was made to rotate rapidly in a round hole in a stationary piece of wood. This method was used by the North American Indians, who improved it by applying the principle of the bow-drill. The Iroquois used the still more ingenious pump-drill. The production of fire by concentrating the rays of the sun by means of a burning-glass was well known to the ancients. North American legends narrate how the great buffalo, careering through the plains, makes sparks flit in the night, and sets the prairie ablaze by his hoofs hitting the rocks. The same idea appears in the Hindu mythology. To save the labor required in these initial processes of procuring light, and to avoid the inconvenience of carrying it about continually, primitive men hit on the expedient of a fire which should burn night and day in a public building. The Egyptians had one in every temple, the Greeks, Latins, and Persians in all towns and villages. Of these the "eternal lamps" in the Byzantine and Catholic churches may be the survival. Even the functions of the State itself, according to some eminent writers, appear to have grown out of the care bestowed on the tribal fire. The first guardians of this fire, it is said, were the earliest public servants, who by degrees appropriated all important offices, as the State itself developed into a vast aggregation of interests. The men who in the Roman Empire took charge of the tribal fire were called the Prytanes. They were fed at the public expense, and they became Magistrates, in whom were combined the powers of Captain, Priest, and King. When Augustus usurped the authority of Imperator, he assumed the powers which belonged to a Board of Flamens, or of Prytanes. He made himself Pontifex Maximus, and assumed the charge of the public fire. The

Hellenic nations, as well as the Aztecs, received their Ambassadors in their temples of fire, where, as at the national hearth, they feasted the foreign guests. The Prytaneion and the State were convertible terms. If by chance the fire in the Roman Temple of Vesta was extinguished, all tribunals, all public or private business, had to stop immediately. No Greek or Roman army crossed the frontier without carrying an altar where the fire taken from the Prytaneion burned night and day. Greek Colonies went not forth without living coals from the altar of Hestia, to light in their new country a fire like that burning at the old home. Architecture, it is supposed, began with the creation of sacred sheds to protect the sacred fire, which was looked upon as a divinity. The fire that burned in the Temple of Vesta was regarded as the very goddess herself. The hearth-fire was kept holy, its flame was to remain bright and pure. According to the Zend Avesta nothing unclean was to be thrown into the fire, and no indecent actions were to be committed before it. To spit in one's fire would be considered in some places an unpardonable offense. Some people were so reverent that they would not blow out a light lest they should render the flame impure with their breath. In the course of time the same reasons which led to the provision for a tribal fire induced every family to have its hearth. The family developed itself only after the married pair and their offspring had their own fireplace. This family fire was at first the privilege of only the aristocracy. The hearth was the very center of the house, as the regia was the sacred center of Rome and the Roman Commonwealth; around the regia the civic and politic institutions developed themselves; and around the hearth the family grew slowly into shape and power. Let us hope it may not decline under the influence of those "modern improvements" which have superseded the hearth-stone and banished from sight the household fire. The Gentile hearth gave a recognized asylum—a right still in full vigor in some countries. The proud saying of the Englishman that his home is his castle is a remnant of this old feeling.

3. In armorial bearings the fire is used to denote those who, being ambitious of honor, perform brave actions with an ardent courage, their thoughts always aspiring as the fire tends upwards. A flame of fire is more frequently used as a charge in France and Germany than in England, where, however, there are fire-balls or bombs, fire-beacons, firebrands, and fire-buckets, etc., in abundance.

FIRE-ALARM.—An alarm given of a fire or conflagration. In barracks or camp it is sounded on the drum or bugle, or by the discharge of fire-arms by the guard. As soon as the fire is observed, the sentinel on post cries "Fire!" adding the number of his post. If the danger appears great, he discharges his piece before calling out. When a fire breaks out, or any alarm is raised in a garrison, all guards are immediately under arms.

FIRE AND SWORD.—By the law of Scotland, although decree may be given in a civil action against an absent defender, no criminal sentence can be pronounced unless the accused be present. But to resist a criminal citation is to rebel against the law of the land, and in former times might be treated as treason. In this view, letters of *fire and sword* were occasionally issued by the Privy Council. These letters were directed to the Sheriff of the county, authorizing him to call in the assistance of the country, and to proceed to the extremities which the terrible words fire and sword indicate, should such proceedings be necessary for apprehending the accused party. Lord Stair describes this remedy as the "last legal execution, warranting all manner of force of arms that is competent in war." The same course might be resorted to where the decree of a Court was resisted; and the object with which letters of fire and sword were more frequently issued than any other was to enable the Sheriff to dislodge refractory tenants who retained possession contrary to the order of the Judge or the diligence of the law. By the modern practice the Judge may, of course, always call in the aid of the military to apprehend an accused party, or to enforce a decree where the ordinary means have proved unavailing.

FIRE-ARMS.—Fire-arms may be defined as vessels, of whatever form, used in the propulsion of shot, shell, or bullets to a greater or less distance by the action of gunpowder exploded within them. They have played so great a part in the world's story that their invention, development, and science deserve careful analysis. At a more advanced period, an obvious division of the subject into cannon, mortars, and small-arms presents itself; but in the infancy of the invention, and amid the obscurity enshrouding it, we can only seek to inquire into the origin of fire-arms generally. The invention of gunpowder bears so directly upon the gradual introduction of fire-arms that it will be well to consider the two discoveries concurrently. The widely prevalent notion that gunpowder was the *invention* of Friar Bacon, and that cannon were first used by Edward III. of England, must be at once discarded. It is certain that gunpowder differed in no conspicuous degree from the *Greek fire* of the Byzantine Emperors, nor from the *terrestrial thunder* of China and India, where it had been known for many centuries before the chivalry of Europe began to fall beneath its leveling power. "Niter," says Sir George Staunton, "is the natural and daily produce of China and India; and there, accordingly, the knowledge of gunpowder seems to be coeval with that of the most distant historic events." The earlier Arab historians call saltpeter "Chinese snow" and "Chinese salt;" and the most ancient records of China itself show that, when they were written, fire-works were well known several hundred years before the Christian era. From these and other circumstances, it is indubitable that gunpowder was used by the Chinese as an explosive compound in prehistoric times; when they first discovered or applied its power as a propellant is less easily determined. There is an account of a bamboo tube being used, from which the "impetuous dart" was hurled a distance of 100 feet; this was at a very early period, but it is difficult to say precisely when. It is recorded, however, that in 618 B.C., during the Taing-off dynasty, a cannon was employed bearing the inscription: "I hurl death to the traitor, and extermination to the rebel." This must almost necessarily have been of metal. We have also curious evidence in regard to the armament of the great wall; for Captain Parish, who accompanied Lord Macartney's mission, reported that "the soles of the embrasures were pierced with small holes, similar to those used in Europe for the reception of the swivels of wall-pieces. The holes appear to be part of the original construction of the wall, and it seems difficult to assign to them any other purpose than that of resistance to the recoil of fire-arms." If this surmise be correct, the use of jingalls would be carried back to three centuries at least before the Christian era. Stone mortars, throwing missiles of 12 lbs. to a distance of 300 paces, are particularly mentioned as having been employed in 757 A.D. by Thang's army; and in 1232 A.D. it is incontestable that the Chinese besieged in Caïfong-fou used cannon against their Mongol enemies. Thus, the Chinese must be allowed to have established their claim to an early practical knowledge of gunpowder and its effects.

It seems likely, however, that the principles of fire-arms reached Europe from India rather than China, and that country has equal, if not superior, claims to the first acquaintance with the art. The ancient Sanscrit writings appear to point very plainly to the operation of some primitive sort of cannon, when, in recording the wars of the Egyptian Hercules in India, it is stated that the sages remained unconcerned as spectators of the attack on their stronghold, till an assault was attempted, when they repulsed it with whirlwinds and thunders, hurling destruction on the invaders; and a Greek historian of Alexander's campaign testifies that the Hindus had the means of discharging flames and missiles on their enemies from a distance. These Indian philosophers seem, from the writings of Ctesias and Ælian, to have also possessed an unquenchable fire similar to that employed later by the Greeks. Passing from these very early times, in which there is reason to believe that some sort of great-gun was employed, we come to the comparatively recent date, 1200 A.D., when their use is established beyond a doubt, for Chaséd, the Hindu bard, writes (in stanza 257) that the culivers and cannons made a loud report when they were fired off, and that the noise of the ball was heard at the distance of about ten coss, which is more than three quarters of a mile. In 1258 the vizier of the King of Delhi went forth to meet the Ambassador of Hulaku, the grandson of Genghis Khan, with 3000 carriages of fire-works (in the sense of weapons, probably a sort of rude muskets). In 1368, 300 gun-carriages were captured by Muhammed Shah Bahmiani. The use of cannon had so far advanced in India by 1482 that they were even used for naval purposes; shells having been employed two years earlier by the Sovereign of Guzerat. In 1500 the Portuguese had matchlockmen to contend with, as well as heavy ordnance. Pigafetta, in 1511, found the town of Borneo defended by 62 pieces of cannon mounted on the walls. So much for the antiquity and apparently common use of fire-arms in China and India, at times long antecedent to any knowledge of them in Europe, and during the period at which they were scarcely developed in an effectual degree. Most of the pieces discovered in India, and supposed to be of early manufacture, are composed of parallel iron bars welded together, and very often they had a movable breech-piece. The knowledge of gunpowder and fire-arms may be presumed to have extended in a westerly direction through the Arabs, whom we find using them possibly in 711 A.D., under the name of *manjaniks*, and certainly very early in the fourteenth century. The Byzantine Emperor Leo introduced "fire-tubes" between 890 and 911, for use in connection with Greek fire; and there can be little doubt that these were a species of cannon, probably of small bore. In Spain, both the Moors and Christians used artillery as early as the twelfth century.

Friar Bacon was conspicuous among his contemporaries for his general learning, and we have no evidence to show whether he discovered the ingredients of gunpowder independently of all foreign aid, or whether he derived the knowledge from some ancient MSS.; the latter, however, seems the more likely conclusion, as Sir F. Palgrave brought to light in the Bodleian Library a letter from a Spanish friar, Brother Ferrarius, who was a contemporary of Bacon, in which the materials of Greek fire are detailed, differing only in proportions, and in these but slightly, from real gunpowder. That the latter was identified of old with Greek fire is shown by the name "Crake," applied to the first cannon used. This word, which still survives in "cracker," is pointed out by Sir F. Palgrave to be nothing more than a Norman corruption of "Grec." Bacon's announcement dates from 1216; but the powder of his time, as made in the West, was not readily explosive, since the materials were but roughly cleared of impurities, and then mixed together on a slab, and probably little use could be made of it as a propellant until the process of granulating had been introduced by Bertholdus Schwartz in 1320. Immediately after this discovery, cannon of small size appeared in the armory of almost every State, as if their use had been known previously, although no practical effect had been given to the knowledge, on account of the badness of the powder manufactured. These cannon generally consisted of a smaller barrel or chamber to receive the charge, which fitted into a larger one containing the projectile. It may be safely assumed that these weapons, if terrifying from their noise, were tolerably harmless—at least to the enemy—in their practice. In 1326 the Florentine Republic ordered the making of iron shot and cannon for the defense of its villages. In 1327 Edward III. used "crakeys of war" against the Scotch; in 1339, ten cannons were employed in the siege of Cambray. By 1346, various improvements had been made; and we find in the same year the Consuls of Bruges witnessing experiments by one Peter, a tinman, who had constructed a cannon with a square bore, to throw a cubical shot of about 11 lbs.; his bolt passed both walls of the town, and unfortunately killed a man on the other side. We have the authority of Villani for believing that Edward III. had three cannon at Crécy; but the cannon then made were, from the little knowledge of casting, limited to about the size of modern duck-guns, and, as has been remarked, three very inferior muskets could have had but little to do with putting 50,000 men to flight. Up to this time European ordnance had been kept back by the rarity and high prices of sulphur, saltpeter, and iron, the last having been so scarce in England that it was thought necessary to forbid its exportation by a statute. Still, crude as was their form, and small their number, fire-arms had established a firm footing in Christendom: their mission of civilization, and, paradoxical as it may appear, of humanity, had begun. With the first killing discharge, the doom of feudalism had gone forth. Plated armor no longer availed against the weapon of the peasant; and the mailed chivalry, the sinews of previous battles, who had trampled with their iron heels upon popular rights, no longer could carry all before them, but, like other soldiers, were now as loath to be slain by unseen foes as the veriest villain in the host. The people discovered their powers of contending with the noblesse; by degrees they rose for liberty and suppressed the tyrannies of the petty lords who had long held them as mere bondsmen. In war, again, as artillery became more general, so the slaughter of battles diminished, for an army outmaneuvered was an army at the enemy's mercy, and therefore beaten; whereas previously, in the hand-to-hand fights where victors and vanquished mixed pell-mell in single combat, a victory could only be really won when there were no foes left to slay. A battle as great as that at Crécy might now be gained with a loss to the vanquished of not more than 1000 men, instead of the 30,000 who are said to have fallen victims to the English sword or bow.

Dating from the reign of Edward III., the employment of cannon and bombards in siege-operations became more or less general. Froissart records that the Black Prince took bombards, cannon, and Greek fire to the reduction of the castle of Romozantin in 1356, but it does not appear that he availed himself of fire-arms at the battle of Poitiers in the same year. The bombards seem to have been short, capacious vessels, from which stone balls were shot with small charges to a short distance, and at considerable elevation; they were essentially the parents of the present bombs or mortars. The cannon, on the other hand, were, for some time at least, of extremely small bore, scarcely larger than muskets of the eighteenth century; they discharged leaden bullets, and would have probably been used as hand-weapons but for their cumbrous and heavy workmanship, which necessitated small carriages. Arms of this description are doubtless those referred to as having been brought by Richard II. to the siege of St. Malo, to the number of 400 pieces, where they are said to have kept up an incessant fire day and night on the town *without* success. In the fifteenth century, armies for siege-operations were usually accompanied by great and small guns, the latter being intended to keep down the fire of the besieged while the large bombards were being loaded, an operation requiring no small time. These guns were gradually improved, but it was not until the reign of Henry VIII. that the founders succeeded in casting iron ordnance, to the entire exclusion, until quite the present day, of cannon formed of square or rounded bars welded together. England had even then become famous for the workmanship of its ordnance. A gun found in the wreck of the *Mary Rose*, which sunk at Spithead in the above king's reign, shows that a degree of excellence had been attained in the manufacture of artillery little inferior to that which has lasted till our own day, when rifled ordnance are rapidly superseding cannon of smooth bores. Still, so late as Henry's reign, although great-guns were found very serviceable in siege and naval operations, where the defenses of those days offered but a trifling resistance to their power, they appear to have been looked upon rather as an incumbrance than an advantage with armies in the field. This is attributed partly to the heavy character of the guns themselves, and especially of their carriages, but more particularly to the badness, or rather absence, of the necessary roads for their transport. In 1552 it is recorded in the State-papers that the "kinges ordonauns [were] unable to pass over Stanes More towards Carlile." As time passed on, the details of the manufacture were improved, the general principles remaining the same; the size of the guns increased, while the proportionate weight of the carriages diminished; limbers were added, and the equipage of a gun gradually perfected and lightened. With increased caliber, to which augmented range was usually added, the number of cannon—at one period enormous—taken with an army was by degrees reduced, until now a certain standard proportion between artillery and infantry is ordinarily maintained. Three guns to a thousand infantry is the proportion now considered best. Of course this proportion differs with the opinions of various Commanders; but the greatest modern Generals have always acted on the maxim that it is wasteful to send a soldier on any duty of danger which a ball can be made to perform. As a weapon of offense, Vauban doubled the utility of heavy ordnance when he applied the ricochet system of firing. Napoleon may almost be said to have won his battles by artillery, for he rarely, if ever, brought his infantry into action except as supports, until a way had been opened for them, or a panic caused, by the massed fire of large batteries of guns. The Duke of Wellington also devoted the greatest attention to his ordnance-train; while, referring to recent events, the campaigns of Lord Clyde in India were remarkable instances of the use of artillery being pushed with abundant success to its greatest limit. During the Franco German War of 1870–71 the Prussians were considered somewhat behind the age in their use of artillery.

Cannon of widely varying bores have at different periods been cast, and the various sorts became so numerous in Continental armies as at one time to cause much inconvenience from the large quantities of ammunition which it was necessary to carry. Gustavus Adolphus set the example of reducing his guns to a few standard calibers, and the same improvement was immediately adopted systematically in the French and other armies. The mortar differs from all other guns in its solidity of form, its shortness, and its large bore. The object is the projection of shells by a more or less vertical fire, with the intention of breaking through and destroying, by weight and explosion together, roofs of magazines, public buildings, and so on, or of sinking a shell deep into earthworks of a fortress, in which it shall explode as a most deadly mine. The mortar arose naturally out of the old bombard, and doubtless deviated by degrees more and more from the cannon. In very early days, we read in Arabian authors of a cylinder hewn in the rock at Alexandria, and used as a mortar. Such a cylinder, and of large size, is still to be seen at Gibraltar, where it was employed in the last siege against the Spanish, when it was made to discharge volleys of large stones, which, spreading at times to a distance of 500 yards, constituted a formidable means of defense. In recent years nearly all guns fire shells, so that the specific necessity for mortars has greatly diminished. A gun is a frustum of a right cone, with a cylinder (bore) removed around the axis; from which it follows that the thickness of metal is greatest at the breech, where it has to withstand the effect of ignited powder in its most condensed and therefore most powerful state. Guns are first cast in loam or dry sand, then turned to the required shape, and lastly bored with the minutest accuracy. Formerly they were cast with the bore already formed; but the direction was rarely correct, and the surface scarcely ever strictly even.

An article on fire-arms would be incomplete without some allusion to the progress attained in small-arms. In the fifteenth century the smallest sort of cannon were probably at times mounted and used as hand-guns. From this the step to the arquebus was rapid; that weapon developed as years passed into the clumsy matchlock; that into the firelock and flint-musket; then the percussion-musket; and lastly into the beautiful rifles of our own day, which have culminated in the central-fire breech-loaders. For diminutives, small arquebuses were made to do duty as horse-pistols; genuine pistols succeeded them; these were gradually improved and reduced in size till they have culminated in the saloon-pistol, available for a waist-coat pocket, and the deadly revolver, with its multiplied shooting power. All these weapons are described under their respective heads. See *Cannon*, *Ordnance*, and *Small-arms*.

FIRE-ARROW.—An arrow or dart furnished with a match impregnated with powder and sulphur, and used for incendiary purposes.

FIRE-BALL.—Fire-balls are projectiles of an oval shape, formed of sacks of canvas filled with combustible composition. They are used to light up the enemy's works, and are loaded with shells to prevent them from being approached. The materials needed in their manufacture are strong, close canvas (sail-cloth); rope; cartridge-thread; red chalk; slow-match; loaded shells; and pitch. A composition of 8 parts of saltpeter, as it comes from the refinery; 2 of pulverized sulphur, and 1 of antimony are passed through sieve No. 2. These materials are mixed in the hands, passed through sieve No. 4, moistened with $\frac{1}{30}$ their weight of water, and passed again through the same sieve. The following utensils are required besides those necessary for grinding and preparing the composition: a wooden pattern; red chalk; one pair shears; collar-needles; mallet; small gauge, of the caliber of the fire-balls; scoop; tarred links; one wooden mold; two wooden drifts 20 inches long, one of them 1½ inch and the other 2½ to 4 inches in diameter; and two wooden pins 4½ inches long, the small end the size of a paper fuse.

To make the sack, mark out the pieces by means of the pattern, and cut them with the shears; baste two or three thicknesses together, according to the strength of the canvas; sew three or more together, enough to make the sack; leave one end open, forming a mouth for charging; turn the bag to bring the seams on the inside. The mouth may be made fast to an iron hoop, large enough to admit the shell, with which the fire-ball is loaded. Charge the shell with powder and put in a slow fuse. Dip the tarred link into the melted rosin, pitch, and tallow, and fasten it with twine to the shell around the fuse-hole. Place the sack in the mold and secure the mouth to it. Put the shell with the tarred link in the bottom of the sack, the fuse-hole downward, and fasten the shell down with twine passed through the sides of the sack, or with a piece of canvas secured to the sides; put in the composition with a scoop and ram it, first with the small drift, and when it is half the height of the projectile, with the large drift, driving it with the mallet. Continue in this way until the sack is filled to the top. Close the mouth of the sack, sewing the pieces together.

The ball is furnished with an iron bottom to prevent it from being broken by the force of the charge in the mortar. To make the bottom, the iron, .2

inch thick, is cut in a circular form, heated and partly shaped with a set-hammer in a concave wooden former; it is again heated and finished in an iron former. It is then put into a lathe where the outer edge is trimmed and chamfered to the thickness of one-eighth inch. The iron bottom is attached to the ball with cement; the bottom is filled about one third full with the cement, and the loaded end of the fire-ball is inserted in it and left to cool. The ball is next covered and strengthened with a network made of spun yarn or cord from .25 to .5 inch thick according to the size of the ball. This network is commenced at the bottom of the sack and terminates at the top in a strong loop which forms a handle for carrying the ball. Fire-balls are dipped in a composition of equal parts of pitch and rosin made warm. The ball when finished should pass through the large shell-gauge.

To prime the balls, make four holes about 3 inches below the top by driving in the greased wooden pins 2 inches deep. When the ball is to be primed, take out these pins and fill the holes with fuses and with two strands of quick match, held fast by the composition; leave room in the priming-hole for coiling the quick-match and cover it with a piece of canvas fastened with four nails. The balls are not primed until they are to be fired. See *Fire-works.*

FIRE-BAVIN.—A bundle of brushwood employed in fire-ships, and for other incendiary purposes.

FIREBRAND MINE.—A variety of mine that preceded the *powder-mine* in the Middle Ages.

FIRE-BUCKET.—A bucket to convey water for extinguishing fires. To each set of quarters in a Garrison there are allotted a certain number of fire-buckets.

FIRE-CROSS.—An ancient token used in Scotland for the nation to take up arms.

FIRE-EATER.—A name applied to a soldier who is notoriously fond of being in action.

FIRE-HOOPS. — A combustible invented by the Knights of Malta to throw among their besiegers, and afterwards used in boarding Turkish galleys.

FIRELOCK.—The name applied on its introduction, in 1690, to the old musket, which produced fire by the concussion of flint and steel, to distinguish it from the *matchlock* previously in use, which had been fired by the insertion of a lighted match at the powder-pan. Writers of the earliest part of the eighteenth century called firelocks "asnaphans," a word obviously corrupted from the Dutch *snaphaan*, and leading to the inference that they were brought to England by William III. and his Dutch auxiliaries. Their first invention is, however, involved in obscurity. The weapon was superseded before 1830 by the percussion-musket; which, in its turn, has now yielded to the rifle. See *Matchlock.*

FIRE-MASTER.—In the artillery, a Commissioned Officer who formerly gave the directions and proportions of all ingredients for each composition required in fire-works, whether for the service of war or for rejoicings and recreation.

FIRE-MASTER'S MATE.—In the artillery, a Commissioned Officer whose duty it was to aid and assist the Chief Fire-master; he was required to be skilled in every kind of laboratory works.

FIRE OF GREATEST RANGE.—The fire obtained by giving the piece the greatest elevation it can take on its carriage, and employing the largest charge used for that caliber. This kind of fire is very injurious to the carriage, and is employed only in testing.

FIRE-PAN.—A pan for holding or conveying fire; especially, the receptacle for the priming in a gun.

FIRE-SHIP.—A vessel, usually an old one, filled with combustibles, sent in among a hostile squadron, and there fired, in the hope of destroying some of the ships, or at least of producing great confusion. Livy mentions the use of such by the Rhodians, B.C. 190; but among the first occasions in modern times when they are known to have been employed were by the Dutch in the Scheldt during the War of Independence in the Netherlands, and shortly after by the English, in 1588, against the Spanish Armada. The Chinese tried them against the British fleet before Canton in 1857, but unsuccessfully. The service of navigating one of these ships into the midst of an enemy, there firing it, and then attempting to escape, is always fraught with great risk of failure and disaster.

FIRE-STEEL.—A steel used in connection with a flint for striking fire. Now little used.

FIRE-STONE.—A composition placed in a shell with the bursting charge to set fire to ships, buildings, etc. It is made by stirring niter, sulphur, antimony, and rosin in a mixture of melted tallow and turpentine. It is cast in molds made of rocket-paper. A priming of fuse-composition is driven in a hole to insure its ignition.

FIRE-SWAB.—The bunch of rope-yarns sometimes secured to the tampion, saturated with water to cool the gun in action, and to swab up any grains of powder.

FIRE-WORKER.—Formerly an assistant to the Fire-master. In the early organization of the British artillery, this title was given to the junior subaltern grade, the designation of the officer being Lieutenant Fire-worker. See *Fire-master.*

FIRE-WORKS.—Military fire-works comprise preparations for the service of *cannon ammunition*, and for *signal*, *light*, *incendiary*, and *defensive* and *offensive* purposes.

Preparations for the Service of Ammunition.—The preparations for the service of ammunition are *slow-match*, *quick-match*, *port-fires*, *friction-tubes*, and *fuses*. Slow-match is used to preserve fire. It may be made of hemp or cotton rope; if made of hemp, the rope is saturated with acetate of lead, or the lye of wood-ashes; if made of cotton, it is only necessary that the strands be well twisted. Slow-match burns from four to five inches in an hour. Quick-match is made of cotton-yarn (candle-wick) saturated with a composition of mealed powder and gummed spirits; after saturation the yarn is wound on a reel, sprinkled (dredged) with mealed powder, and left to dry. It is used to communicate fire, and burns at the rate of one yard in thirteen seconds. The rate of burning may be much increased by inclosing it in a thin paper tube called a *leader*. Port-fires are paper cases containing a composition, the flame of which is capable of quickly igniting primers, quick-match, etc. The composition consists of niter, sulphur, and mealed powder. A port-fire is about 22 inches long, and burns with an intense flame for ten minutes. Friction-tubes are at present the principal preparations for firing cannon; the advantages are portability and certainty of fire. They also afford the means of firing a piece situated at a distance, and do not attract the notice of the enemy's marksmen at night. They are made of two brass tubes soldered at right angles. The upper or short tube contains a charge of friction-powder and the roughed extremity of a wire loop; the long tube is filled with rifle-powder, and is inserted in the vent of the piece. When the extremity of the loop is violently pulled, by means of a lanyard, through its hole in the long tube, sufficient heat is generated to ignite the friction-powder which surrounds it, and this communicates with the grain-powder in the longer tube. The charge of grained powder has sufficient force to pass through the longest vent and penetrate several thicknesses of cartridge-cloth. The composition of friction-powder is one part of chlorate of potassa and two parts of sulphuret of antimony. Fuses are the means used to ignite the bursting-charge of a hollow projectile at any desired moment of its flight; they may be classified according to their mode of operation, as time-fuses, percussion-fuses, and combination-fuses.

Fire-works for Signals.—Rockets for signals are composed of a paper case charged with composition, a pot filled with ornaments, and a light stick to give direction. Rockets are denominated by the interior diameter of the case. The most common sizes are the .75-inch, 1-inch, and 1.5-inch. The decorations of rockets are stars, serpents, marrons, gold-rain, rain of fire, etc. STARS are formed by driving the composition, moistened with alcohol and gum-arabic in solution, in port-fire molds. It is then cut into lengths about ⅝ inch, and dredged with mealed powder. The case of a SERPENT is similar to that of a rocket, but the interior diameter is only .4 inch. The composition is driven in, and the top is closed with moist plaster of Paris. It is primed by inserting a small piece of quick-match through the vent; it may be made to explode by driving mealed powder over the composition. The composition is 3 parts of niter, 3 parts of sulphur, 16 parts of mealed powder, and ½ part of charcoal. MARRONS are small paper shells, or cubes, filled with grained powder, and primed with a short piece of quick-match, which is inserted in a hole punctured in one of the corners. To increase the resistance of the shell it is wrapped with twine, and dipped in *kit* composition. The stick is a tapering piece of pine about nine times the length of the case, and is tied to the side of the case to guide the rocket in its flight. The position of the center of gravity depends on the diameter of the case; for a 2-inch rocket it should be 2½ inches in rear of the vent; and it is verified by balancing on a knife-edge. The prescribed dimensions of the stick should be observed, for if the stick be too heavy the rocket will not rise to a proper height; if it be too light it will not rise vertically. A very brilliant BLUE-LIGHT may be made of the following ingredients, viz.: 14 parts of niter, 3.7 parts of sulphur, 1 part of realgar, and 1 part of mealed powder. The brilliancy depends on the purity and thorough incorporation of the ingredients. The composition may be driven in a paper case, and afterward cut off to suit the required time of burning. Both ends of the case are closed with paper caps, and primed with quick-match, in order that one or both ends may be lighted at pleasure. A light in which the composition is 1.5 inches diameter can be easily distinguished at the distance of 15 miles.

INCENDIARY FIRE-WORKS.—The incendiary preparations are *fire-stone, carcasses, incendiary-match*, and *hot-shot*. FIRE-STONE is a composition that burns slowly but intensely; it is placed in a shell, along with the bursting charge, for the purpose of setting fire to ships, buildings, etc. It is composed of 10 parts of niter, 4 parts of sulphur, 1 part of antimony, and 3 parts of rosin. The composition having been properly pulverized and mixed is added to melted tallow and turpentine in small quantities. Each portion of the composition should be well stirred with long wooden spatulas to prevent it from taking fire, and each portion should be melted before another is added. When fire-stone is to be used in shells it is cast into cylindrical molds made by rolling rocket-paper around a former, and securing it with glue. A small hole is formed in the composition by placing a paper tube in the center of each mold. When the melted composition has become hard, this hole is filled with a priming of fuse composition, driven as in the case of a fuse. The object of this priming is to insure the ignition of the fire-stone by the flame of the bursting-charge. There are two sizes of molds, the larger for shells above the 8-inch, and the other for the 8-inch and all below it. A CARCASS is a hollow cast iron projectile filled with burning composition, the flame of which issues through four fuse-holes to set fire to combustible objects. The composition is the same as for port-fires, mixed with a small quantity of finely-chopped *tar*, and as much *white turpentine* and *spirits of turpentine* as will give it a compressible consistency. The composition is compactly pressed into the carcass with a drift, so as to fill it entirely. Sticks of wood .5 inch diameter are then inserted into each fuse-hole, with the points touching at the center, so that when withdrawn corresponding holes shall remain in the composition. In each hole thus formed three strands of quick-match are inserted, and held in place by dry port-fire composition, which is pressed around them. About three inches of the quick-match hangs out when the carcass is inserted in the piece; previously to that it is coiled up in the fuse-hole, and closed with a patch of cloth dipped in melted kit. A *common shell* may be loaded as a carcass by placing the bursting-charge on the bottom of the cavity, and covering it with carcass-composition driven in until the shell is nearly full, and then inserting four or five strands of quick-match, secured by driving more composition. This projectile, after burning as a carcass, explodes as a shell. INCENDIARY-MATCH is made by boiling slow-match in a saturated solution of niter, drying it, cutting it into pieces, and plunging it into melted fire-stone. It is principally used in loaded shells. HOT SHOT may be fired for the purpose of setting fire to wooden vessels, buildings, etc. Solid shot are heated in a furnace before firing, to a red heat. The time required to heat a 42-pounder shot to a red heat is about half an hour. The precautions to be observed in loading hot shot are that the cartridge be perfectly tight, so that the powder shall not scatter along the bore, and that a wad of pure clay, or hay soaked in water, be interposed between the cartridge and the shot. When properly loaded the shot may be allowed to cool without igniting the charge. In the British sea-coast service shells are used for incendiary purposes by filling them with molten iron drawn from a small cupola furnace. If the shell be broken on striking, the hot iron is scattered about; if it be not broken, the heat penetrates through the shell with sufficient intensity to set wood on fire.

FIREWORKS FOR LIGHT.—The preparations for producing light are fire-balls, light-balls, tarred links, pitched fascines, and torches. A FIRE-BALL is an oval-shaped canvas sack filled with combustible composition. It is intended to be thrown from a mortar to light up the works of an enemy, and is loaded with a shell to prevent it from being approached and extinguished. The sack is made of sail-cloth, cut into three oval pieces or gores, and sewed together at their edges. Several thicknesses of cloth may be used if necessary. One end of the sack is left open, and, after being sewed, it is turned to bring the seam on the inside. The composition for a fire-ball consists of 8 parts of niter, 2 parts of sulphur, and 1 part of antimony. After having been pulverized, mixed, and sifted, the composition is moistened with one thirtieth of its weight of water, and again passed through a coarse sieve. The ball is filled by pouring a layer of composition into the sack, and placing the shell (fuse down) upon it; after this, the composition is well rammed around and above the shell, and the sack is closed at the top. The bottom of the sack is protected from the force of the charge by an iron cup called a *culot*, and the whole is covered and strengthened with a network of spun-yarn, or wire, and then overlaid with a composition of pitch, rosin, etc. A fire-ball is primed by driving into the top of the composition a greased wooden pin about three inches deep and filling the hole thus formed with fuse-composition, driven as in a fuse; space is left at the top of each hole for two strands of quick-match, which are fastened by driving the composition upon them. The fuse-hole is covered with a patch saturated with kit-composition, which is a mixture of rosin, beeswax, pitch, and tallow. LIGHT-BALLS are made in the same manner as fire-balls, except that, being used to light up our own works, the shell is omitted. TARRED LINKS are used for lighting up a rampart, defile, etc., or for incendiary purposes. They consist of coils of soft rope, placed on top of each other, and loosely tied together; the exterior diameter of the coil is 6 inches, and the interior 3 inches. They are immersed for about ten minutes in a composition of 20 parts of *pitch* and 1 of *tallow*, and then shaped under water; when dry, they are plunged in a composition of equal parts of *pitch* and *rosin*, and rolled in tow or sawdust. To prevent the composition from sticking to the hands, they should be previously covered with linseed-oil. Two links are put into a rampart-grate, separated by shavings. They burn one hour in calm weather, and half an hour in a high wind, and are not extinguished by rain. To light up a defile, the links are placed about 250 feet apart; to light up a march, the men who carry the grates should be placed to the leeward of the column, and about 300 feet apart. Fagots of vine-twigs, or other very combustible wood, about 20 inches long and 4 inches diameter, tied in three places with iron wire, may be treated in the same manner, and used for the same purposes as links. The incendiary properties of PITCHED FASCINES may be increased by dipping the ends in melted rock-fire; when used for this purpose, they are placed in piles intermingled with shavings, quick-match, bits of port-fires, etc., in order that the whole may take fire at once. A TORCH is a ball of rope impregnated with an inflammable composition, and is fastened to the end of a stick, which is carried in the hand. Old rope, or slow-match, well beaten and untwisted, is boiled in a solution of equal parts of water and niter; after it is dry, tie three or four pieces (each 4 feet long) around the end of a pine stick, about 2 inches in diameter and 4 feet long; cover the whole with a mixture of equal parts of sulphur and mealed powder, moistened with brandy, and fill the intervals between the cords with a paste of 3 parts of sulphur and 1 of quicklime. When it is dry, cover the whole with the following composition: 3 parts of pitch, 3 parts of Venice turpentine, and ½ part of turpentine. Torches are lighted at the top, which is cracked with a mallet; they burn from one and a quarter to two hours. In lighting the march of a column, the men who carry torches should be about 100 feet apart.

OFFENSIVE AND DEFENSIVE FIREWORKS.—The principal preparations of this class, employed in modern warfare, are *bags of powder* and the *light-barrels*. BAGS OF POWDER may be used to blow down gates, stockades, or to form breaches in thin walls. The *petard* was formerly employed for these purposes, but it is now generally thrown aside. From trials made in England, it has been shown that a sand-bag (covered with tar, and sanded to prevent it from sticking) containing 50 pounds of powder, has sufficient force to blow down a gate formed of 4-inch oak scantling, and supported by posts 10 inches in diameter and 8 feet apart; and a bag containing 60 pounds of powder, and weighted with two or three bags of earth, has sufficient force to make a large hole in a 14-inch brick wall. The effect of the explosion may be much increased by making three sides of the bag of leather, and the fourth of canvas, which should rest against the object. A suitable means of exploding bags of powder is a *time-fuse*, or the ordinary *safety-fuse* for blasting rocks. A LIGHT-BARREL is a common powder-barrel pierced with numerous holes, and filled with shavings that have been soaked in a composition of pitch and rosin; it serves to light up a breach, or the bottom of a ditch.

ORNAMENTAL FIREWORKS.—Ornamental fireworks are employed to celebrate great events, as victories, treaties of peace, funerals, etc. They are divided into *fixed pieces*, *movable pieces*, *decorative pieces*, and preparations for *communicating fire* from one part of a piece to another. The different effects are produced by modifying the proportions of the ingredients of the burning composition so as to quicken or retard combustion, or by introducing substances that give color and brilliancy to the flame. The fixed pieces are *lances*, *petards*, *gerbes*, *flames*, etc. LANCES are small paper tubes from .2 to .4 inch diameter, filled with a composition which emits a brilliant light in burning. Instead of a single composition, each lance may contain two or more compositions, which in turn emit different-colored flames. The case should be as thin as possible, in order that the color of the flame of the composition may not be affected by that of the paper. Lances are generally employed to form figures; this is done by dipping one end in glue, and sticking them in holes arranged after a certain design, in a piece of wood-work. PETARDS are small paper cartridges filled with powder. One end is entirely choked, and the other is left partially open for the passage of a strand of quick-match, designed to set fire to the powder. A petard is usually placed at the fixed end of a lance, that the flame may terminate with an explosion; they are also used to imitate the fire of musketry. GERBES are strong paper tubes or cases filled with a burning composition. The ends are tamped with moist plaster of Paris or with clay; through one a hole is bored extending a short distance into the composition, that it may emit a long sheaf or *gerbe* of brilliant sparks. The diameter of the case is about one inch, and the length depends upon the required time of burning. The number of blows to each ladleful of composition is ten. Gerbes are secured to the frame of the piece with wire or strong twine, and pointed in the direction that the flame is to take. FLAMES consist of lance or star composition, driven into paper cases or earthen vases. The diameter of the burning surface should be large, to give intensity to the flame. Lance-composition is driven dry, and with a slight pressure. Star-composition should be moistened, and driven with greater pressure than the preceding.

The movable pieces are the *sky-rockets*, *tourbillions*, *saxons*, *jets*, *Roman candles*, *paper shells*, etc. SKY-ROCKETS are the same as the signal-rockets, except that the composition is arranged to give out a more brilliant train of fire. The TOURBILLION is a case filled with sky-rocket composition, and which moves with an upward spiral motion. The spiral motion is produced by six holes—two lateral holes (one on each side), for the rotary motion, and four on the under side, for the upward motion. It is steadied by two wings formed by attaching a piece of a hoop to the middle of the case, and at right angles to its length. To give it a proper initial direction, a hole is made through the center of the case to fit on a vertical spindle, which is fastened to an upright post. The SAXON is the same as the tourbillion, except that it is only pierced with the central and two lateral holes, and has no wings. The central hole is placed on a horizontal spindle, and the piece has the appearance of a revolving sun. JETS are rocket-cases filled with a burning composition; they are attached to the circumference of a wheel, or the end of a movable arm, to set it in motion. They also produce the effect of gerbes; and to increase the circle of fire, they are inclined to the radius at an angle of 20° or 30°. A ROMAN CANDLE is a strong paper tube containing stars, which are successively thrown out by a small charge of powder placed under each star. A slow-burning composition is placed over each star to prevent all of them from taking fire at once. PAPER SHELLS are filled with decorative pieces, and fired from a common mortar. It contains a small bursting-charge of powder, and has a fuse regulated to ignite it when the shell reaches the summit of its trajectory. The shell is made by pasting several layers of thick paper over a sphere of wood, cutting the covering thus formed in halves, so as to remove the sphere, joining the halves again, and pasting paper over them until the thickness is sufficient to resist the charge of the mortar. Decorative pieces are the *stars*, *serpents*, *marrons*, etc., described under the head of Rockets.

Preparations for communicating fire from one piece to another are the *quick-match*, *leaders*, *port-fires*, and *mortar-fuses*. The LEADER is a thin paper tube containing a strand of quick-match, and it is united to a piece by pasting pieces of paper over the joint. If the piece is to be fired at once, the leader may be omitted, and strands of quick-match tied together used in its place.

The foregoing pieces are generally mounted on pieces or frames of light wood, and are susceptible of being combined so as to produce a great variety of striking effects. See *Blue-light*, *Carcass-compositions*, *Colored Fires*, *Fire-ball*, *Friction-primers*, *Fuse*, *Gold Rain*, *Hot-shot*, *Incendiary match*, *Lances*, *Lea* *ders, Light-balls, Light-barrel, Lights, Marrons, Petards, Pitched Fascines, Port-fires, Pyrotechny, Quick-match, Rock-fire, Roman Candle, Serpents, Signal-rocket, Slow-match, Stars, Streamers, Sun-cases, Tarred Links, Torches, Tourbillion, Wheel-cases*, and *Wooden Shells.*

FIRING.—The act of discharging fire-arms. Firings are either direct or oblique, and are executed as follows:

The Direct Fire.—The Instructor commands: 1. *Fire by squad*, 2. *Squad*, 3. READY, 4. AIM, 5. FIRE, 6. LOAD. The commands *ready, aim, fire*, and *load* are given with sufficient intervals to allow them to be executed as officially stated. The rear-rank men incline the upper part of the body forward, so that their pieces may reach as far as possible beyond the front rank. Upon the completion of the load, the Instructor continues the firing by the commands: 1. *Squad*, 2. AIM, 3. FIRE, 4. LOAD. To cease firing, the Instructor commands: 1. *Cease*, 2. FIRING. At this command, the men cease firing, reload their pieces if unloaded, and afterward bring them to a *carry. This rule is general.*

Oblique Firings.—The oblique firings are executed to the right and left by the same commands as the direct fire, except that the command *aim* is preceded by the command *right* (or *left*) *oblique*. At the command *right oblique*, the men of both ranks cast their eyes to the right and look steadily at the object. At the command *aim*, the front-rank men aim obliquely to the right, without deranging the feet; each rear-rank man aims obliquely to the right, keeping the right foot in its place, at the same time advancing the left foot about eight inches to the right and front, the toe pointing in the direction he is to fire, the upper part of the body inclining forward, the left knee slightly bent. If the command be *left oblique*, the men of both ranks cast their eyes to the left; the rear-rank men at the same time raise their pieces to a vertical position. At the command *aim*, the front-rank men aim obliquely to the left, without deranging the feet; each rear-rank man, keeping the right foot in its place, brings down his piece to the left of his front-rank man, at the same time advancing his left foot about eight inches to the left and front, the toe pointing in the direction he is to fire, inclining the upper part of the body forward, the left knee slightly bent. In recovering arms from the left oblique, each rear-rank man, at the command *recover*, raises his piece to a vertical position, and, at the command *arms*, comes to the position of ready. In both cases at the command *load*, the men of each rank come to the position of load, as prescribed in the direct fire, the rear-rank men bringing back the foot in advance to the proper position in loading, and bringing back their pieces as in recovering arms.

To Fire by File.—The Instructor commands: 1. *Fire by file*, 2. *Squad*, 3. READY, 4. COMMENCE FIRING. At the fourth command, the file on the right aim and fire, reload, fire again, and so on. The second file aim at the instant the first lower their pieces to the position of the first motion of load, fire, and conform to what has been prescribed for the first file, and so on to the left. After the first fire each man loads and fires independently of the others.

To Fire by Rank.—The Instructor commands: 1. *Fire by rank*, 2. *Squad*, 3. READY, 4. *Rear-rank*, 5. AIM, 6. FIRE, 7. LOAD. The rear rank aims, fires, and loads, as already explained. As soon as the Instructor sees several pieces of the rear rank in the position of ready, he commands: 1. *Front rank*, 2. AIM, 3. FIRE, 4. LOAD. The Instructor causes the ranks to alternate in firing, until he commands: 1. *Cease*, 2. FIRING.

To Fire Kneeling.—The pieces being loaded, and at a carry, the Instructor commands: 1. *Fire kneeling*, 2. KNEEL. Bring the left toe squarely to the front, and plant the right foot so that the toe shall be about twelve inches to the rear and twelve inches to the left of the left heel, the feet at right angles; kneel on the right knee, bending the left; drop the muzzle to the front, support the piece with the left hand at the lower band, the forearm resting on the left knee, the right hand grasping the small of the stock, muzzle at the height of the chin. If formed in two ranks, at the first command for kneeling, the rear-rank men take a side-step to the right. After rising they take a side-step to the left and cover their front-rank men. The firings are executed by the same commands as when standing. The piece is brought to a ready by simply cocking it, and is supported in aiming by the left elbow, resting on the left knee. To load, lower the piece, support it with the left hand at the lower

Fire Kneeling.

band, the left forearm resting on the left knee, the barrel sloping downward. In firing obliquely, the rear-rank men aim through the same intervals as when standing, and do not support the left elbow on the left knee.

To Fire Lying Down.—The squad being in one rank, pieces loaded and at an order, the Instructor commands: 1. *Fire lying down*, 2. LIE DOWN. At the second command, each man drops on his knees, places his left hand, well forward, on the ground, and lies flat on his belly; the piece is lowered at the same time with the right hand, the toe and muzzle resting on the ground, the barrel up, the left hand at the lower band, the left elbow on the ground, the right hand at the small of the stock, opposite the neck. At the command *commence firing*, cock the piece; raise it with both hands, press the butt against the shoulder, and, resting on both elbows, aim and fire. To load the piece, steady it at the lower band with the left hand, the toe and muzzle resting on the ground, insert the cartridge with the right hand. To rise, the Instructor commands: 1. *Squad*, 2. RISE. Draw back the piece slightly; grasp it at the lower band with the right hand, and bring it to a vertical position, barrel to the rear, the butt opposite the neck; with the aid of both hands raise the body to a vertical position, on the knees; bring back the piece, the toe in a line with the right knee; throw the weight of the body backward, rise on the balls of both feet, and return to the position of order arms. Troops will never be permitted to fire lying down when the enemy, advancing to the attack, arrives within effective range. See *Fire.*

FIRING-BATTERY.—The efficiency of a mine or system of mines depends upon the accuracy and certainty with which they may be discharged at the right moment, this moment being when the hostile vessel is directly over any particular mine of the group. This may be done at will, the position of the ship having been determined by intersection, or the vessel herself may be made to complete the circuit by striking a circuit-closer.

The testing-room should be in the most secure part of the work. It should be about 16 feet square, with a suitable store-room attached. From the testing-room a gallery, about 4 feet wide by 5 high, passes out through or under the fort. In this gallery are placed frames for supporting the cables, so arranged that there will be no confusion as to the identity of the cables. The frames should be of bronze; iron is apt to oxidize, and wood is liable to decay and render constant repairs necessary. The frames occupy half the breadth of the gallery, leaving the other half for access and examination of the cables. Each cable is attached to a binding-screw of the testing-table, the binding-screws being numbered to correspond with the mines.

In the testing-room is the apparatus for producing the agent by which the mines are to be exploded. This may be frictional electricity, a magnet current generated by a dynamo-electrical machine, but usually it is a galvanic current similar to that for electric-telegraph purposes. The main conditions for such a battery are that it should remain constant—that is, that it should be capable of being allowed to remain mounted and ready for use for say one month—and that it shall generate a sufficient quantity of electricity to allow of a certain amount of leak or fault in a cable and yet fire a fuse beyond the leak.

The Leclanché battery is the one best adapted and most generally used. The advantages possessed by it are the absence of chemical action when the battery-circuit is not complete, and consequently there is no waste of material; it requires but little looking after; it may be kept ready for action in store without in any way deteriorating; and, finally, it is comparatively inexpensive.

FIG. 1.

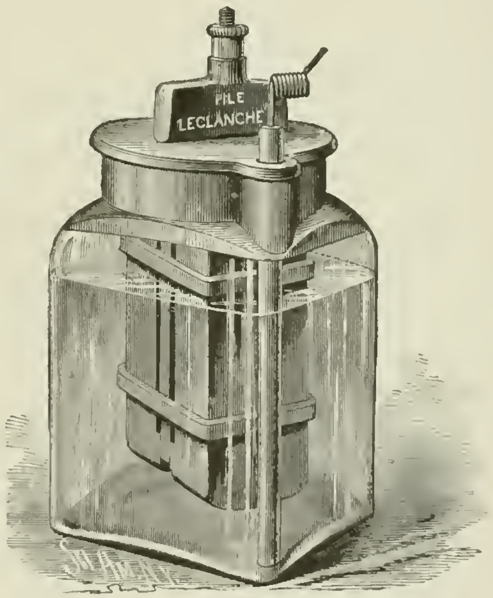


FIG. 2.

Fig. 1 shows the old form or *disque* battery, so successfully employed in extensive mining operations. Fig. 2 shows the improved form, or the Leclanché prism-battery. In this battery the porous cup is dispensed with, and in its place is substituted a pair of compressed "prisms" or plaques which are simply attached to the carbons by means of two strong rubber bands. The prisms contain all of the materials heretofore employed in the porous cup, combined with others not before used, compressed into this compact and convenient form by powerful hydraulic machinery.

The positive pole is composed of a plate of carbon inserted between and in connection with two compressed prisms of peroxide of manganese and carbon, combined with other materials, the three being held firmly together by rubber bands. The negative pole is composed of a pencil of amalgamated zinc. The two poles are placed in a solution of sal-ammoniac and water, contained in a glass jar with a cover, through which the carbon head and the zinc project. When the elements have become exhausted from long service, or other cause, to renew the battery it is only necessary to take off the prisms, soak the carbon (below the bead) in hot water, attach new prisms, and set up as before, with a sufficient quantity of new zinc and sal-ammoniac.

The firing-battery should be suited to the nature of the fuses employed, and should possess considerable excess of power in order to overcome accidental defects, such as increased resistance in the communications, or defective insulation in the electric cable in connection with the mine. A battery just sufficiently powerful to fire a fuse on the shore, with the electric cable, etc., in circuit, but not submerged, would not be unlikely to fail after the cable has been submerged in sea-water. In such a case it is recommended that the battery-power determined by such an experiment on shore be doubled for actual work. For all practical purposes this test can be made by firing a fuse of known quality through a resistance equivalent to that of the cable. Double the number of cells necessary to effect this would be required for the submerged cables, etc. See *Galvanism.*

FIRING-PARTY.—Those who are selected or detailed to fire over the grave of any one buried with military honors.

FIRING PIN.—That part of the breech-mechanism whose function is to explode the cartridge. It ordinarily has a slot cut in it near the head for the end of a screw which, projecting into it, prevents it from coming out of place. The hammer having been drawn back to full-cock, and the trigger pulled, the head of the *firing-pin* is thrown forward, strikes the head of the cartridge and explodes it. See *Hadley Firing-pin* and *Springfield Rifle.*

FIRST SERGEANT.—The ranking Non-commissioned Officer in a company. He has immediate charge of all enlisted men of the company and company property; has command of it during formations, and calls the roll. He also makes all details, keeps the roster, etc. See *Orderly Sergeant.*

FISCAL YEAR.—In the United States army, funds appropriated for any given fiscal year cannot be used to liquidate liabilities incurred in any other fiscal year, nor can funds be used for any other class of expenditure than that to which they were appropriated. At the termination of each fiscal year all amounts of moneys that are represented by certificates, drafts, or checks, issued by the Treasurer, or by any Disbursing

Officer of any Department of the Government upon the Treasurer or any Assistant Treasurer, or designated depositary of the United States, or upon any national bank designated as a depositary of the United States, and which shall be represented on the books of either of such offices as standing to the credit of any Disbursing Officer, and which were issued to facilitate the payment of warrants, or for any other purpose in liquidation of a debt due from the United States, and which have for three years or more remained outstanding, unsatisfied, and unpaid, are deposited by the Treasurer, to be covered into the Treasury by warrant, and to be carried to the credit of the parties in whose favor such certificates, drafts, or checks were respectively issued, or to the persons who are entitled to receive pay therefor, and into an appropriation account to be denominated "outstanding liabilities." The payee or the *bona-fide* holder of any draft or check the amount of which has been deposited and covered into the Treasury pursuant to the above paragraph, on presenting the same to the proper Officer of the Treasury, is entitled to have it paid by the settlement of an account and the issuing of a warrant in his favor, according to the practice in other cases of authorized and liquidated claims against the United States.

The following well-known Treasury regulations bear on this subject:

1. Any Treasury draft or any check drawn by a public Disbursing Officer still in service, which shall be presented for payment before it shall have been issued three full fiscal years, will be paid in the usual manner by the office or bank on which it is drawn, and from funds to the credit of the drawer. Thus any such draft or check issued on or after July 1, 1873, will be paid as above stated until June 30, 1877, and the same rule will apply for subsequent years.

Any such draft or check which has been issued for a longer period than three full fiscal years will be paid only by the settlement of an account as provided by law; and for this purpose the draft or check will be transmitted to the Secretary of the Treasury for the necessary action.

2. The reports of independent Treasury Officers, national-bank depositaries, and public Disbursing Officers will be rendered promptly to the Secretary of the Treasury at the close of each fiscal year.

3. Whenever any Disbursing Officer of the United States shall cease to act in that capacity, he will at once inform the Secretary of the Treasury whether he has any public funds to his credit in any office or bank, and, if so, what checks, if any, he has drawn against the same which are still outstanding and unpaid. Until satisfactory information of this character shall have been furnished, the whole amount of such moneys will be held to meet the payment of his checks properly payable therefrom.

4. At the close of each fiscal year the Treasurer, the several Assistant Treasurers, and designated and national-bank depositaries, will also render to the Secretary of the Treasury a list of all Disbursing Officers' accounts still unclosed which have been opened on the books of their respective offices or banks more than three fiscal years, giving in each case the name and official designation of the officer, the date when the account with him was opened, and the balance remaining to his credit.

5. In case of the death, resignation, or the removal of a public Disbursing Officer, any check previously drawn by him and not presented for payment within four months of its date will not be paid until its correctness shall have been attested by the Secretary or Assistant Secretary of the Treasury.

FISHERMAN'S KNOT.—A knot used in pontoning to fasten the cables to the rings of the anchors. See *Knots*.

FISHING-SPARS.—In artillery material, the spars of wood placed parallel to the spars to be strengthened, by lashing them to one another.

FISHTAIL WIND.—An expression employed in target-practice with small-arms for a rear wind which is variable in direction.

FISSURE.—A small chasm where a small breach has been made, as in a fort, citadel, etc.

FISTULA.—In farriery, the name given to an abscess usually situated on the withers of a horse, and discharging pus. Sometimes it appears on the head, when it is called poll evil.

FITCHY.—Crosses are said, in Heraldry, to be fitchy when the lower branch ends in a sharp point. Crosses are supposed to have been so sharpened to enable the primitive Christians to stick them into the ground for devotional purposes. Also written *Fitché*.

FITTINGS.—The name given to certain fixtures in a barrack or on board a military transport for the purpose of keeping up a current of pure air, and for receiving the equipments and arms.

FITZROY DEFLECTOR.—An instrument designed to prevent the need of making a correction for the inclination of the trunnions. It consists of a block (capable of movement round a pin fixed on the breech of the gun) containing the sight-slot, which is kept making the same permanent angle of deflection with the perpendicular to the axis of the trunnions by means of a heavy bob underneath, however much the inclination of the trunnions may alter. A spirit-level is also added.

FIX BAYONET.—A command in the Manual of Arms, executed as follows: The Instructor commands, 1. *Fix*, 2. BAYONET. Grasp the piece with the left hand, forearm horizontal; carry it to the left side, the butt striking the ground about eight inches to the rear of the left toe, the piece inclined to the front, the left wrist resting against the thigh; carry the right hand to the shank of the bayonet. (Two.) Draw the bayonet from the scabbard, and fix it on the end of the barrel; drop the right hand by the side.

1. *Carry*, 2. ARMS. Raise the piece with the left hand and place it against the right shoulder; resume the carry with the right hand. (Two.) Drop the left hand by the side. See *Manual of Arms*, Fig. 6.

FIXED AMMUNITION.—When the cartridge is attached to the projectile, the two together are termed *fixed ammunition;* this is employed for the service with boat-howitzers. It has the advantage of great convenience in the hurried preparations that frequently precede boat-operations, and the guns can be served the more rapidly with fixed ammunition; simultaneous loading is more simple, and the cartridge is sure to be placed correctly in the bore, and not with the choked end first, as is sometimes the case when the projectile and the cartridge are separate. Fixed ammunition has, however, the great disadvantage that in packing or stowing much greater space is required, and it is more difficult to arrange and to preserve.

The following implements are required in *fixing* ammunition:

Barrels for powder; 1 *funnel;* 1 *set of powder-measures;* 1 *straight-edge*, to strike the measures with; *barrels; tubs*, formed of barrels sawed in two, or *boxes*, for the cartridge-bags; 2 *paulins;* 2 *benches;* 12 *choking-sticks*, 6 with holes in them and 6 slit; 6 *knives;* 6 *hand-barrows* with 4 legs and a box, and *paulins* to cover them; caliber-gauges for the cartridge-bags and for fixed ammunition (they may be made of wood); 6 *stools;* 1 *wheel-barrow;* 1 *mallet;* 1 *copper chisel;* 1 *copper drift*, or a *wrench*, to open the powder-barrels.

In fixing shot or case for smooth-bore field-guns, the bags should be filled in the small magazine or filling-room. The assistant holds the pipe of the funnel in the mouth of the bag with both hands, the bag pressed close against the pipe. The gauger heaps up the measure with powder, strikes it level with the straight-edge, and pours it into the funnel. When about 25 bags are filled the gauger takes a filled bag with one hand, squeezing the bag upon the powder; he gives it a blow with the other hand on the top and bottom of the bag, twisting the mouth of the bag down upon the powder at the same time; he then tries it with the small gauge through which it should pass with not more than .25 inch play; should it not do this, the bag is emptied and rejected. These bags, filled and gauged, are placed upright in a tub or box and carried by the gaugers into the finishing-room, where the men are placed in pairs, sitting astride on a bench facing each other. One of them opens a bag and levels the powder, the other inserts the sabot of a strapped shot square upon the powder and draws up the end of the bag over the shot; the first man passes about 4 feet of twine through the pierced stick and makes two turns and a double hitch with the end at the top of the sabot; he makes a knot in the end of the twine, inserts it into the slit in the other choking-stick, and tightens the double hitch by rolling the twine on the sticks and bearing upon the sabot; he then takes out the end of the twine from the slit, ties it in a hard knot, which he tightens with the assistance of the choking-stick, and cuts the twine off near the knot. The second man turns down the mouth of the bag over the sabot, and the first makes a similar tie in the groove; he makes another tie below the sabot, the twine being lodged between it and the powder to prevent the latter from sifting in between the bag and the sabot; he then runs the paper cylinder over the cartridge and sabot, leaving about two inches of the end of the cartridge uncovered, and he makes a tie similar to the others in the groove of the sabot. He now holds the shot in the left hand and examines it, striking the sabot with the right hand, if necessary, to bring it straight; if the shot be properly fixed, the sabot and the bag will have the same axis; the seams should be between two straps, and the knots should be neither on the seams nor on the straps. The assistants pass the cartridges through the large gauge, which is .04 inch larger than the large gauge for the shot. If the size be correct, they put on the paper cap, lay the cartridges on their sides in the box of the hand-barrow, and carry them to the magazine. Those which will not pass through the gauge are handed back to the fixers, who sever the strings and put them up anew.

Canisters for smooth-bore field-guns are fixed in the same manner as shot, except that the first tie is made in the upper groove of the sabot; the cylinder is tied in the lower groove. The caps must be cut somewhat shorter than those for shot-cartridges. *For mountain-howitzers* the sabots have but one groove, the first tie is omitted, and the cartridge is covered with a cap only. When the shot is attached to the sabot by a single band of canvas, or when it is placed in the sabot without any strap, the cartridge-bag is drawn over it and tied on top; for this purpose the bag should have an additional length of from 2½ to 3 inches. When sabots cannot be obtained, place upon the powder one layer of tow about .2 inch thick, forming a bed for the shot; tie the bag over the shot and around the tow; the bag requires to be 1 inch longer than for strapped shot. See *Ammunition* and *Field and Mountain Ammunition.*

FIXED BATTERY.—The batteries used during the second period of siege-operations are both fixed and movable. The fixed batteries contain the siege-guns and mortars of the heaviest caliber and longest range; whilst the movable batteries will consist of field-guns and small mortars which can take up temporarily any favorable positions for damaging the defenses. As a general rule the fixed gun-batteries should be placed in enfilading positions whenever such can be found for them, delivering their fire always within the interior slope of the face enfiladed, and in preference taking a slant reverse direction on the terre-plein of the face. Parts of the defenses which cannot be reached by enfilade must be counter-battered by batteries which can obtain a full-front or a slant-front view upon them. The mortar-batteries will receive such positions as are most favorable for reaching the interior of the defenses; preference being given to those in which the longest lines of the defenses can be brought within the range and direction of the shells; avoiding, whenever practicable, throwing them across the positions occupied by the approaches, so as to insure a shell being landed within some point of the defenses, and to avoid the accidents from shells falling short of their butt or bursting prematurely. The positions of the fixed batteries of rifled guns and heavy mortars will be usually along the position of the first parallel and some 30 or 40 yards in advance of it, so that its service shall not interfere with that of the parallel, nor the service of the latter with it—a point of great importance for the efficient service of each; and being in advance of the parallel, the troops in the latter will not be annoyed by the discharge of the guns, which they might be were they in their rear. As the ricochet of rifled guns with the elongated shot is uncertain, and, from the great range at which the guns fire, the plunge of the projectile would be necessarily great and unfavorable to ricochet, positions for fixed enfilading batteries of smooth-bore siege-guns may be taken either in advance of the second parallel or, better, in some of the demi-parallels, so as to bring them within some 500 yards of the line to be enfiladed, as the range very favorable for the ricochet of these pieces.

The number of guns in each enfilading battery will depend upon the extent of terre-plein within the works upon which an enfilade or a slant reverse fire can be obtained. Usually the number of guns should not exceed seven, nor be less than three; the number being regulated by the importance to the besieged of the line enfiladed. In each counter-battery there should be at least as many guns as the defenses can bring to bear upon it; always enough to completely control the fire of the point counter-battered. Whilst batteries containing a large number of guns are exposed to greater casualties than smaller ones, weak batteries are liable to be silenced by a concentrated fire upon them from the defenses. As a general rule, batteries at different distances should be so placed that the more advanced should not be in the line of fire of those in the rear. The danger from accidents from a violation of this rule is not very great if the batteries are several hundred yards apart, and the point fired at distant; or until the trenches get near the position of the third parallel. At this stage great precaution is necessary in regulating the fire so that the shot may not fall into or explode too near the trenches. See *Batteries* and *Movable Battery.*

FIXED PIVOT.—The fixed point about which any line of troops wheels. This point is marked by a soldier or guide who stands fast or marks time while the line wheels.

FLAG OF PROTECTION.—It is customary to designate by certain flags (usually yellow) the hospitals in places which are shelled, so that the besieging enemy may avoid firing on them. The same has been done in battles, when hospitals are situated within the field of the engagement. Honorable belligerents often request that the hospitals within the territory of the enemy may be thus designated, so that they may be spared. An honorable belligerent allows himself to be guided by flags or signals of protection as much as the contingencies and the necessities of the fight will permit. It is justly considered an act of bad faith, of infamy or fiendishness, to deceive the enemy by flags of protection. Such an act of bad faith may be good cause for refusing to respect such flags. The besieging belligerent has sometimes requested the besieged to designate the buildings containing collections of works of art, scientific museums, astronomical observatories, or precious libraries, so that their destruction may be avoided as much as possible.

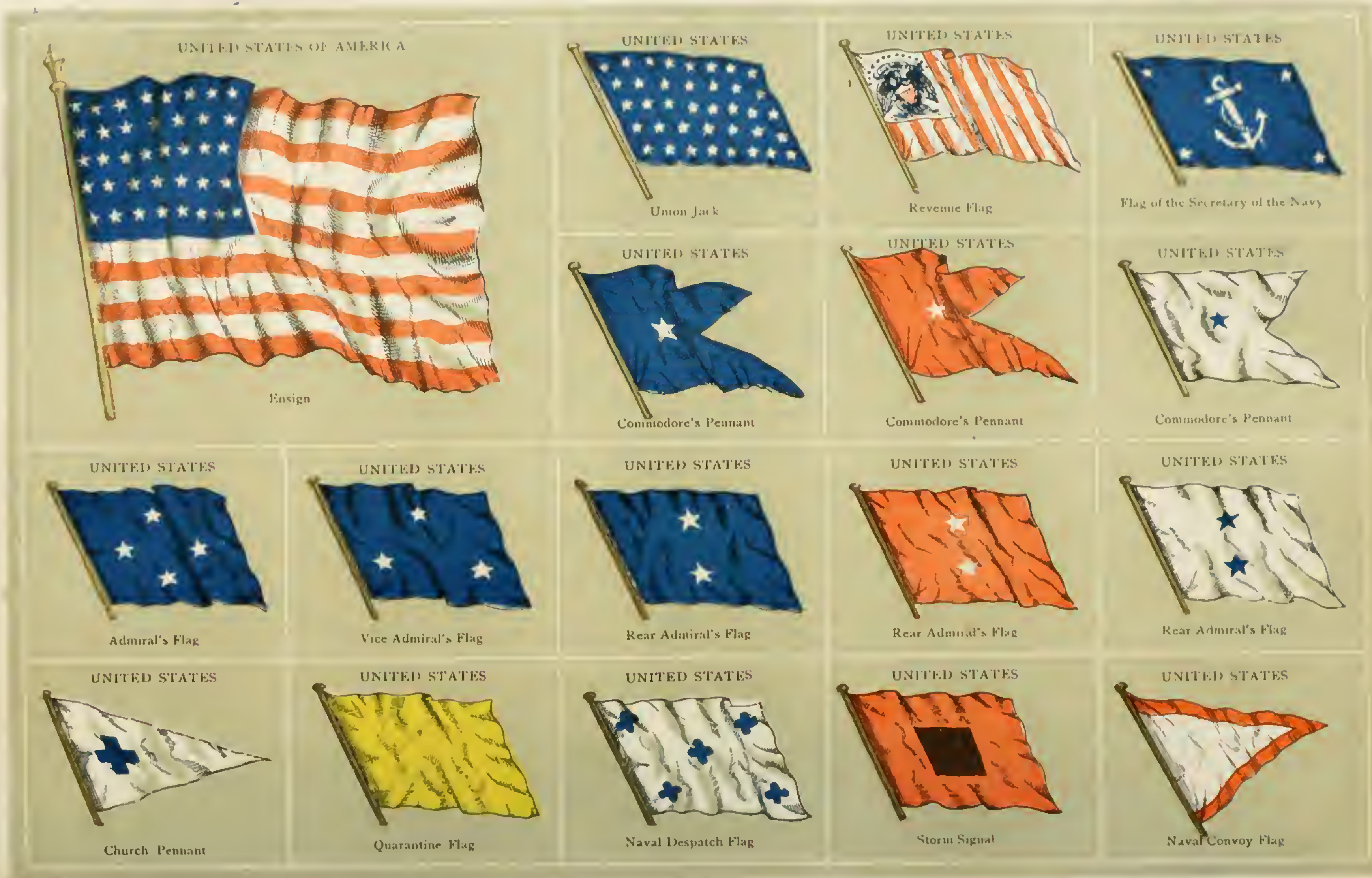
FLAG OF THE PROPHET (Sanjak-Sherif).—The sacred banner of the Mohammedans. It was originally of a white color, and was composed of the turban of the Koreish, captured by Mohammed. A black flag was, however, soon substituted in its place, consisting of the curtain that hung before the door of Ayeshah, one of the Prophet's wives. This flag, regarded by the Mohammedans as their most sacred relic, first came into the possession of the followers of Omar at Damascus; it afterwards fell into the hands of the Abbasi; then passed into those of the Caliphs of Bagdad and Kahira; and, at a later period, was brought into Europe by Amurath III. It was covered with forty-two wrappings of silk, deposited in a costly casket, and preserved in a chapel in the interior of the seraglio, where it is guarded by several Emirs, with constant prayers. The banner unfolded at the commencement of a war, and likewise carefully preserved, is not the same, although it is believed by the people to be so.

FLAG OF TRUCE.—A white flag carried by an officer sent to communicate with the enemy. The bearer cannot insist upon being admitted. He must always be admitted with great caution. Unnecessary frequency is carefully to be avoided. If the bearer of a flag of truce offer himself during an engagement, he can be admitted as a very rare exception only. It is no breach of good faith to retain such a flag of truce, if admitted during the engagement. Firing is not required to cease on the appearance of a flag of truce in battle. If he, presenting himself during an engagement, is killed or wounded, it furnishes no ground of complaint whatever. If it be discovered, and fairly proved, that a flag of truce has been abused for surreptitiously obtaining military knowledge, the bearer of the flag thus abusing his sacred character is deemed a spy. So sacred is the character of a flag of truce, and so necessary is its sacredness, that while its abuse is an especially heinous offense, great caution is requisite, on the other hand, in convicting the bearer as a spy. See *Truce*.

FLAGS.—Cloths of light materials, capable of being extended by the wind, and designed to make known some facts or wants to spectators. In the Army a flag is the ensign carried as its distinguishing mark by each regiment; and also a small banner, with which the ground to be occupied is marked out. In the Navy the flag is of more importance, often constituting the only means vessels have of communicating with each other or with the shore. For this purpose devices of conspicuous colors (usually black, white, red, yellow, or blue) are hoisted at the mast-head or at the gaff. The flags having three forms, a very few patterns in each shape give sufficient combinations of three or four flags to express any letter or word in the language. The flag is also a sign of the rank of the principal person on board a vessel, as the "Royal Standard," containing the Arms of the United Kingdom, which is only hoisted when a member of the Royal Family is on board; the "Anchor of Hope," on a red ground, denoting the Admiralty; the Pennant, which specifies the ship of war; and the Ensign, which denotes the nation. Naturally the regular English flag was used by the Colonies in their early days, and that was commonly the cross of St. George. The Puritan spirit was shown when Endicott, the Governor of Massachusetts, cut the cross from the flag because it was a Romanist emblem. The Colonial flags varied in color, it being sufficient if ground and cross differed. Now and then a pine-tree was figured in the upper left-hand quarter of the cross, and one flag had only this tree for a symbol. When Sir Edmund Andros was Governor he established a special flag for New England, a white field with a St. George cross, and in the center "J. R.," *Jacobus Rex* (James, King), surmounted by a crown. The Revolution brought in all manner of devices for flags and banners, the larger portion bearing mottoes more or less defiant of the Foreign Government. Soon after the engagement at Lexington the volunteers from Connecticut put on their flag the Arms of the Colony, with the legend "*Qui transtulit, sustinet*" (He who brought us over will sustain us). The Colonial flag of New Amsterdam (substantially the present Arms of New York City) was carried by armed vessels sailing out of New York—a beaver being the principal figure, indicative of both the industry of the Dutch people and the wealth of the fur trade. The day after the battle of Bunker Hill, Putnam displayed a flag with a red ground, having on one side the Connecticut motto, and on the other the words "An appeal to Heaven." The earliest vessels sailing under Washington's authority displayed the Pine-tree flag. An early flag in the Southern States was designed by Colonel Moultrie and displayed at Charleston in September, 1775. It was blue, with a white crescent in the upper corner next the staff; afterwards the word "Liberty" was added. At Cambridge, Mass., January 2, 1776, Washington displayed the original of the present United States flag, consisting of thirteen stripes of red and white, with a St. Andrew cross in place of the stars. The Rattlesnake flag was used to some extent in two forms: in one the snake was intact, and under the figure the words "Don't Tread on Me;" in the other form the snake was in thirteen pieces, and the legend was "Join or Die;" and in some cases the snake had thirteen rattles. Ten days after the Declaration of Independence, Congress directed the style of the flag of the United States, as heretofore described, with its later modifications. By the War Department the stars in the union are usually so placed as to form one large star. In the Navy the stars are in straight lines, perpendicular and horizontal. The Union Jack is a blue ground with all the stars but no stripes. During the War of the Rebellion the Seceding States had a number of distinct flags. Early in 1861, however, their Congress decided upon what was popularly called the "Stars and Bars," which was composed of three broad horizontal bars, the two outer ones red and the middle one white, with a blue "union" containing nine stars in a circle. Some variations were afterwards made, but they need not be noticed. There are many flags which designate special or personal position or authority. Among such are Royal Standards, Flag Officers' flags, etc. An Admiral's flag is usually the flag of the country which such an Admiral serves, with the exception of the "union." The flag of the Admirals, Vice Admirals, and Rear Admirals of the United States is rectangular, and consists of thirteen alternate red and white stripes. The Admiral hoists this at the main; the Vice Admiral at the fore; the Rear Admiral at the mizzen. Should there be two Rear Admirals present, the Junior hoists at the mizzen a flag similar to the one described, with the addition of two stars in the left-hand corner. The Commodore's flag differs from that of the Admiral in form alone, being swallow-tail instead of rectangular. Should the President go afloat, the American flag is carried in the bow of his barge or hoisted at the main of the vessel on board of which he may be. In foreign countries the Royal Standard is displayed at ceremonies in honor of the Sovereign or at which the Sovereign may be present. A flag placed midway on the staff, or "half-mast," is a sign of mourning. A flag reversed or upside down indicates distress. Salutes are made by dipping the flag by hauling it down a short distance and immediately raising it several times in succession. See *American Flag*, *Banner*, *Ensign*, *Garrison-flag*, *Pennon*, *Post-flag*, *Red Flag*, *Standard*, *Storm-flag*, and *Union Jack*.

FLAG-STAFF.—A mast or pole on which a flag or standard is hung. One is allowed to each fort or fortress, and to the Governors of the several English Dependencies, to Commanders-in-Chief, and to officers commanding divisions or districts of the army.

FLAIL.—An ancient weapon composed of a shaft and several whips, the latter either with or without iron points; or else of the shaft, to which was fastened a chain ending in an iron ball, or a wooden one studded with iron. The flail, which was well known in Switzerland and Germany during the fifteenth century, was also used in England since the period of the Norman Conquest, and existed during the reign of Henry VIII., though then but little used, and only in the trenches and on board ships. The military flail with a short handle belonged more particularly to Russia and Japan.


UNITED STATES OF AMERICA
Ensign
UNITED STATES
Union Jack
UNITED STATES
Revenue Flag
UNITED STATES
Flag of the Secretary of the Navy
UNITED STATES
Commodore's Pennant
UNITED STATES
Commodore's Pennant
UNITED STATES
Commodore's Pennant
UNITED STATES
Admiral's Flag
UNITED STATES
Vice Admiral's Flag
UNITED STATES
Rear Admiral's Flag
UNITED STATES
Rear Admiral's Flag
UNITED STATES
Rear Admiral's Flag
UNITED STATES
Church Pennant
UNITED STATES
Quarantine Flag
UNITED STATES
Naval Despatch Flag
UNITED STATES
Storm Signal
UNITED STATES
Naval Convoy Flag


FRANCE
Ensign.
FRANCE
Admiral's Flag.
(A *square* Flag.)
FRANCE
Vice Admiral's Flag,
In Boats and Tenders.
(A *square* Flag.)
PORTUGAL
Royal Flag
FRANCE
Rear Admiral's Flag,
In Boats and Tenders.
(A *square* Flag.)
FRANCE
Pilot Flag
PORTUGAL
Ensign
JAPAN
Pilot Flag
PORTUGAL
Pilot Flag
SPAIN
Pilot Flag
BRAZIL
Pilot Flag
ARGENTINE REPUBLIC
Pilot Flag
AUSTRIA
Pilot Flag
NEW ZEALAND
Ensign
SOCIETY ISLANDS
Ensign
LIBERIA
Ensign
EGYPT
Ensign


HAWAIIAN ISLANDS
Royal Standard
HAWAIIAN ISLANDS
Ensign
CHINA*
Imperial Government Flag
SAN DOMINGO
Man of War Flag
SAN DOMINGO
Admiral's Flag
PONTIFICAL STATES
Man of War Flag
PONTIFICAL STATES
Merchant Flag
SWITZERLAND
Ensign
BOLIVIA
Ensign
GUATEMALA
Man of War Flag.
The Merchant Flag has no device
ITALY
Royal Standard
ITALY
Admiral's Flag.
The Vice Admiral carries the 2 upper balls
The Rear " " upper ball
ITALY
Man of War Flag
ARGENTINE REPUBLIC
Man of War Flag.
Admiral's, square Flag, same style.
ITALY
Merchant Flag
ITALY
Commodore's Pennant
ARGENTINE REPUBLIC
Merchant Flag


TURKEY
Man of War Flag
TURKEY
Merchant Flag
TUNIS
Man of War Flag.
The Merchant Flag is a plain red.
GERMANY
Man of War Flag
GERMANY
Merchant Flag
NETHERLANDS
Pilot Flag
RUSSIA
Pilot Flag
DENMARK
Pilot Flag
GERMANY
GOTT MIT UNS 13 70.
Imperial Standard
NORWAY
Pilot Flag
SWEDEN
Pilot Flag
GERMANY
Pilot Flag
DENMARK
Commodore's Pennant
DENMARK
Admiral's Flag
DENMARK
Royal Standard
DENMARK
Man of War Flag
DENMARK
Merchant Flag

NICARAGUA — Ensign

BELGIUM — Pilot Flag

BELGIUM — Royal Standard
The Ensign is plain yellow centre.

BELGIUM — Admiral and Lieut. Admiral's Flag.
The Vice Admiral carries the 3 upper balls
The Rear " " 2 " "

BELGIUM — Commodore's Pennant

HONDURAS — Ensign

SIAM — Ensign

GREECE — Man of War Flag

GREECE — Merchant Flag

MOROCCO — Ensign

COSTA RICA — Man of War Flag

AUSTRIA — Grand Admiral's Flag

AUSTRIA — Man of War Flag.
The Admiral's, Vice and Rear Admiral's is a *square* Flag, with black, yellow and black in upper left hand corner.

AUSTRIA — Imperial Standard

UNITED STATES OF COLOMBIA — Ensign

AUSTRIA — Commodore's Pennant

AUSTRIA — Merchant Flag


PARAGUAY
Merchant Flag
PARAGUAY
Man of War Flag
PARAGUAY
Admiral's Flag.
URUGUAY
Ensign
VENEZUELA
Man of War Flag.
Merchant Flag has no device on yellow stripe.
SAN SALVADOR
Man of War Flag
SAN SALVADOR
Merchant Flag
HAYTI
Man of War Flag.
Merchant Flag has no device in centre
MEXICO
Merchant Flag
MEXICO
Man of War Flag.
The Admiral's is a *square* Flag, same style
PERU
Captain de Navies (Commodore)
BRAZIL
Imperial Standard
BRAZIL
Admiral's Flag
BRAZIL
Ensign
BRAZIL
Commodore's Pennant
PERU
Rear and Vice Admiral
PERU
National Ensign or Man of War Flag
The Merchant Flag has no device in centre
CHILI
National Standard.
The Ensign has no device in centre.
CHILI
Vice Admiral's, Rear Admiral's, and Division Commander's Flag
ECUADOR
Ensign


RUSSIA
Admiral's Flag
RUSSIA
Merchant Flag.
RUSSIA
Man of War Flag
RUSSIA
Imperial Standard
TRIPOLI
Ensign
NETHERLANDS
Ensign
The Admiral and Lieutenant Admiral carries four white balls on red stripe; the Vice Admiral three, the Rear Admiral two.
NETHERLANDS
Royal Flag
NORWAY
Admiral's Flag
NORWAY
Commodore's Pennant
NORWAY
Royal Flag
NORWAY
Man of War
NORWAY
Merchant Flag
PERSIA
Ensign
SWEDEN
Commodore's Pennant
SWEDEN
Royal Flag
SWEDEN
Man of War and Admiral's Flag
SWEDEN
Merchant Flag


GREAT BRITAIN
Royal Standard
GREAT BRITAIN
Pilot Flag
GREAT BRITAIN
Man of War Flag
The Admiral has no Field Piece
The Vice " " " one red ball
The Rear " " " two "
GREAT BRITAIN
Lord High Admiral's Flag
GREAT BRITAIN
Flag of Admiral of the Fleet
GREAT BRITAIN
Prince of Wales' Standard
GREAT BRITAIN
Commodore's Pennant
1st Class hoisted at the main.
2d " " " fore.
SPAIN
Man of War Flag
The Admiral's Flag is square, with the same device
SPAIN
Merchant Flag
GREAT BRITAIN
Flag of Lord Lieutenant of Ireland
GREAT BRITAIN
Naval Reserve Flag
GREAT BRITAIN
Merchant Flag
JAPAN
Admiral's Flag - 1st Rank
JAPAN
Admiral's Flag 2d Rank
JAPAN
Imperial Flag
JAPAN
Admiral's Flag—3d Rank
JAPAN
Man of War Flag
The Admiral's Flag, pro tem, is cut as a Pennant.

FLAM.—A beat or tap upon the drum which was formerly used in the British army when regiments were going through their drill or exercise, every formation being done by tap or beat upon the drum. It was likewise beaten in firing-practice whenever the target was struck.

FLAMBEAU.—A variety of torch made of thick wicks, covered with wax, and used in the streets at night, at illuminations, and in processions.

FLAME-SWORD.—A weapon intended to be used with both hands, and employed in the sixteenth century. This sword should not be mistaken for the *flamberg*.

FLANCH—FLANGE.—The projecting rim of metal on the circumference of a wheel or cylinder to serve as a bearing; for example, the rim on the tire of railway-wheels. The rim of metal round the mouth of gun-caps used with percussion-muskets is called a flange.

FLANCHARDS.—The side-pieces of ancient horse-armor, which joined the front-plate or the breast-piece to the thigh-pieces and croupière.

FLANCHES.—In Heraldry, flanches are composed of arched lines drawn from the upper angles of the escutcheon to the base-points. The arches of the flanches almost meet in the center of the shield. The flanches are an ordinary little used in Scotch Heraldry. Also written *Flanques*.

FLANCHIERE.—A part of horse-armor which covered the flanks and croup as far as the houghs.

FLANCONADE.—In fencing, a term commonly applied to a thrust in the side. See *Fencing*.

FLANGED SYSTEM OF RIFLING.—This system embraces all projectiles upon the cylindrical portion of which are projections which in loading are intended to be inserted into corresponding grooves in the bore of the gun. Under this system may be classed all those projectiles which have projections in the form of studs, ribs, or flanges on their surfaces intended to take the grooves in loading. And it may also be said to comprise all mechanically fitted projectiles like the Whitworth; for the salient departures from a circle, in cross-section of the projectile, may be regarded as flanges, while the corresponding angles in cross-section of the bore, and into which these flanges fit, constitute the grooves. The various modifications of this common system are very great, and none of them can be said to have given entire satisfaction, while all of them have revealed serious faults and shortcomings.

The evident advantages of this system are economy, simplicity, and durability of the projectile. The rifle-motion is communicated with great certainty and regularity. The projectile does not expand by the explosion, and hence gets more windage as the bore warms. As the gun expands and gets weaker, its safety-valve gets larger.

The chief objections are, that both projectile and bore being hard, fracture of one or the other is liable to occur from a projectile jamming; and that unless the bore be made of very hard material, it will be rapidly worn by the friction of the projectile. See *System of Rifling*.

FLANK.—The right or left side of a body of men or a place. Flank presupposes a formation more or less deep. A flank-march is upon the prolongation of the line to which a body faces. Thus, when we say the enemy, by a flank-march, outflanked our right wing, it is understood that the enemy, by marching parallel to our line of battle, put himself in position upon our extreme right. To disturb the flanks of a column or army is to throw an opposing force upon either side of the route that it follows. By this maneuver the march of the column is retarded, or it is forced to a halt; its baggage is sometimes seized, and terror and disorder fall upon the masses. *To flank* is to cover and defend the flanks. We flank a camp by posts placed on the right and left; a corps d'armée is flanked by detachments which take roads parallel to the routes followed by the larger body; smaller columns are flanked by flankers on the right and left, who keep in view the columns, warn them of the approach of an enemy, discover ambuscades, skirmish with them, and fall back when needed upon the mass of the troops.

FLANK-ATTACK.—In warfare, one of the modes of attack whereby the side or flank of an army or body of troops is attacked. Before the introduction of rifled guns and arms, the *attack in front*, by heavy columns of infantry covered by skirmishers and guns, was the usual mode of attack; but since then it has been found, in consequence of the withering and rapid fire of rifles, that, depending alone upon such an attack, a front-advance is attended with extreme danger. Troops advancing in column under such circumstances necessarily break up into skirmishers, the column-form becomes somewhat abandoned, both in the leading columns, supports, and reserves, as each moves up into action. To remedy this, attack in flank or rear is come to be received as the best mode of attack; not that the front-attack is to be altogether given up, for to insure success such an attack is still necessary, though modified; otherwise the enemy would be free to meet and frustrate the flank movements: so that really the attack of the present day is a combination of front and flank.

FLANK-CASEMATE CARRIAGE.—A carriage consisting of two cheeks of wood united by two iron transoms. The chassis consists of two wooden rails three inches apart, and joined by four transoms and assembling-bolts. To the rear end of the top-carriage is attached an eccentric roller, and to each cheek, in front, a roller which, when the eccentric roller is *in gear*, rests on the chassis-rails, giving to the carriage rolling friction. The piece is then easily run in and out of battery, the cannoneers applying themselves to rings and handles on the sides of the cheeks. The front end of the chassis rests on the sole of the embrasure, and is provided with a lunette, through which a pintle drops into the masonry beneath. The rear of the chassis is supported by an iron fork, to the lower extremity of each prong of which is attached a small traverse-wheel. See *Carriage*.

FLANK-COMPANY.—A certain number of troops drawn up on the right or left of a battalion. Thus, when there are grenadiers, they compose the right, and the light infantry the left, flank-company. Grenadiers and light infantry are generally called flank-companies whether attached or not to their battalions; rifle corps are always flankers.

FLANK-DEFENSE. — In fortification, the means adopted in the trace of a work to preserve all parts of it from being unduly exposed to the direct fire of the enemy, such as would be the case if a parapet had alone to protect itself in a direct line upon the besiegers. Again, the face of a work is said to receive *flank-defense*, or to be *flanked*, when the fire of another work is directed parallel or nearly so to its escarp, so as to defend its ditch or the ground in front of it. Any work not so provided would be liable to be captured without difficulty. Take for instance a faultily-constructed work, permitting of the assailants getting close up under the rampart without the defenders seeing them: in this position a few bold, resolute men, with crowbars and a bag of powder, might, by making a cavity in the escarp, destroy a portion of the rampart. To prevent, however, such a possibility, three systems have been devised for giving flanking defense to a permanent work; they are the tenaille system, the bastioned system, and the polygonal system.

FLANKED ANGLE. — In fortification, the angle formed by the flank of the bastion and curtain, or, in other words, that formed by two lines of defense. See *Angle*.

FLANKED DISPOSITION.—In planning or disposing fortifications in relation to the position to be defended, it is very important that the parts shall be so distributed as to obviate certain defects, besides satisfying some other well-known general conditions, such as to bring a *front, flank*, and *cross fire* upon the assailant's columns of attack; or, what is the same, one sheet of fire that will sweep the column from front to rear, another to bear upon each of its flanks so as to cross their fire with each other and with the one from the front. In this way mutual defensive relations are sought to be established between all the parts. To effect this, certain parts are thrown forward towards the enemy to receive his attack; they are denominated *advanced parts;* other portions, denominated *retired parts,* are withdrawn from the enemy, and protect by their fire the advanced parts. This arrangement naturally indicates that the general outline of the plan must present an angular system; some of the angular points, denominated *salients,* being towards the enemy; and others, denominated *re-enterings,* towards the assailed. When such a disposition is made it is denominated a *flanked disposition,* because the enemy's flank is attained by the fire of the retired parts when he is advancing upon the salients. The advanced parts are denominated *faces;* the retired parts, which protect the faces, the *flanks;* the retired part connecting the flanks is the *curtain.* The angle formed by two faces is denominated a *salient angle;* that formed by two retired parts, a *re-entering angle;* and one made by a face and the opposite flank, an *angle of defense.* The line bisecting a salient angle is denominated the *capital;* the distance from a salient to its opposite flank is a *line of defense.*

In planning a work, the interior crest is regarded as the directing line in regulating the dimensions of the faces, flanks, etc., because this line shows the column of fire for the defense. There exists a necessary subordination between the plan, relief, and command of works, which prevents the dimensions of the one being regulated independently of the others; but, without entering into a close examination of this necessary co-relation of the parts, it may be stated generally that faces should vary between thirty and eighty yards, flanks between twenty and forty yards, and curtains should not be less than twelve times the relief. In establishing the co-relations between the different parts of any isolated works or combination of the elements of field fortification, the following facts should, as far as practicable, be observed: 1. The flanks sweep with their fire the ground in front of the faces; remove sectors without fire and dead angles; cross their fire in front of the salients; and take the enemy's column in flank. 2. An acute angle of defense exposes the faces to the fire of the flanks; a too obtuse angle leaves a portion of the ground in front of the face undefended. In the heat of action, the soldier, from his position behind the parapet, naturally brings down his piece, in the act of firing, in a position sensibly perpendicular to that of the interior crest. If every bullet, therefore, took this direction, those delivered just exterior to the parapet flanked would barely clear the men drawn up along it. On this account, and from the fact that unless checked before reaching the ditch the success of the assaulting column is greatly assured, it is better in field-works to make the angles of defense so open that all the fire of the general defense from the flanks shall be thrown from just within the counterscarp outwards; and to insure the flanking of the ditches by cannon, or a body of infantry specially detailed for this duty. 3. The lines of defense should be based upon the skill in handling their weapons of infantry in an ordinary state of efficiency, and allowance must also be made for the ordinary range of distinct vision of such men. The fire of the smooth-bore, with troops in this state, is very effective at 160 yards; and with the best weapons the fire of none but well-trained and special troops can be depended upon much over 300 yards. Particular cases may require the lines of defense to exceed this limit. When they arise they should be specially provided for. The shorter the lines of defense, where the flanking dispositions are good, the longer will the assailant be exposed to the fire of the assailed before he can attain the works, and the greater the chances of checking him. 4. A salient less than 60° is too weak to withstand the effects of weather; the interior space which it incloses is too confined for the maneuvers of the troops; when its faces are not flanked there will be a large sector without fire in front of it. The positions which the assailed can take up to enfilade either face of an acute salient are more favorable to him than in that of an obtuse one, as his guns are thrown farther from and are exposed to a less direct fire of the adjacent face of the salient, and of any other parts of the fortification adjacent to this face. This rule, however, should not be taken as absolute, as many cases may arise where more acute salients can alone be obtained, and in which the troops, being restricted to a passive defense, will require only room enough to load and fire either cannon or muskets. As such salients are necessarily very weak, the approaches to them should be obstructed by every means at hand. 5. The rapidity with which a column of attack approaches, and the short time it remains exposed to the fire of the work unless detained by obstacles in front of the ditch, render its loss, generally, so trifling as not to check its march until it arrives at the crest of the counterscarp. Here, if the ditch is deep, some delay ensues in entering it, during which the column is exposed to a warm fire within short range. When the ditch is entered, a more serious obstacle remains to be encountered in the additional height of the parapet and scarp; and when this obstacle is overcome the enemy presents himself in a fatigued and exhausted state to the bayonets of the assailed, who have mounted on the top of their parapet to meet and drive him back into the ditch. This rule is essential in all isolated works where, from the small size of the garrison, the defense must necessarily be of a passive character, being restricted to a simple repulse of the assailant. 6. Unless the assailed are determined to meet the enemy at the point of the bayonet, they must evacuate their work so soon as he has entered the ditch; a longer delay to retreat would be followed by the most disastrous consequences. The results of innumerable actions prove that the defense with the bayonet is the surest method of repelling the enemy. The assailed, having now become the assailant, are assisted by that moral effect which is produced by a change from a defensive to an offensive attitude. They have, moreover, the advantages of position and freshness over a climbing and exhausted enemy. See *Field-fortification.*

FLANK EN POTENCE.—Any part of the right or left wing formed at a projecting angle with the line. See *Potence.*

FLANKER.—1. A fortification jutting out so as to command the side or flank of an enemy marching to the assault or attack. 2. The dispositions of movable advanced-posts in the directions of the flanks, keeping pace with the progress of the main body, and far enough from it to give it timely warning of a threatened attack, are termed the *flankers.* Generally the head or leading detachment of some force, composed usually of both cavalry and infantry, and if requisite some pioneers, forms the advance of the main body of the advanced-guard, for the purpose of searching all the ground within a dangerous proximity, and of clearing the way for the advancing columns. Through this detachment a communication is kept up with the flankers, and all the ground is thus hemmed in around the advancing column by which an enemy might approach it. The strength of the leading detachment will depend greatly upon the character of the country, and upon the state of the weather and season being more or less favorable to the unobserved approach of an enemy. A leading detachment of one fourth the total strength of the advanced-guard; two flank-detachments, to act as flankers, of one eighth; and a rear detachment, acting as a rear-guard, also of one eighth,—taking, in all, one half the total strength of the advanced-guard,—is considered, under ordinary circumstances, a good distribution for the duties to be performed. All the ground within the proximity of the advanced-guard must be carefully searched by it. No invariable rule can be laid down on this subject, everything depending on the character of the country; the state of the weather; and the march being by day or night, as to the more or less dispersed order that can be adopted for examining the ground. The leading detachment, and those on the flanks, should keep in a position, with respect to each other, that will admit of prompt mutual support, and guarding against the approach of an enemy unperceived; the flank-detachments, for this purpose, keeping somewhat to the rear of the leading one. The most advanced portions of these troops should be of cavalry, unless the country be mountainous or very thickly wooded, in which cases infantry is the best arm for the duty.

FLANK-FILES.—The first men on the right and the last men on the left of a battalion, company, etc. When a battalion is drawn up three deep, its flank-files consist of three men, or, as the French call it, file and demi-file. When four deep, the flank-files are termed double files; so that a column formed from any of these alignments will have all its relative flank-files, be the depth of the formation what it may.

FLANK-MARCHES.—Marches made parallel or obliquely to the enemy's position, with a view to turning it or attacking him on the flank. Flank-marches are risky, but there are times when an army must make them and run the risk of exposing its flank in order to gain great advantages. As the greatest danger to which the column is exposed is that of being attacked in flank during the march, a strong detachment should be thrown out on the side next the enemy, to move along in a direction parallel with the column, and sufficiently near to keep up a constant communication with it. The advanced-guard usually becomes the flank-detachment on a flank-march; but it will be well, since the chances of attack are greater, to increase its strength, so that it should be able to hold its ground against any serious effort of the enemy. This detachment should be careful to occupy all defiles, and watch all the roads by which the enemy might appear, until the main body has passed. The baggage becomes, in a case like this, more of an encumbrance than usual. It may be sent to join the army by a circuitous route, at a distance from the enemy, or may move on that flank of its own column which is the safer against attack.

If possible, the march should be concealed from the enemy, keeping him in ignorance of the movement until completed. This cannot always be done, as he is on the alert to observe any movements which may be made. Under no circumstances should the flank-detachment be omitted, as by its skillful use the enemy may be kept in doubt for some time as to the particular character of the march, whether it is to the front, to the rear, or to a flank. If this detachment meets the enemy, it makes a show of resistance and develops the strength of the opposing force. In the mean time the main body moves steadily forward, and, when it has passed sufficiently far, the detachment leaves the position it had held, and retires rapidly, taking, if necessary, a direction different from that of the main body, and subsequently rejoining it by a detour. The enemy will not follow it very far, as he exposes his own flank to the troops which have already passed. When the body of troops making the flank-march is large, as a corps composed of several divisions, there should be several columns, if the nature of the country will admit of it. These columns should be in supporting distance of each other, as required in a march to the front.

Flank tactical marches were frequently made by Frederick the Great to gain a position favorable for an attack on an enemy's wing. On such occasions he formed his army in two columns of companies at full distance, so that by wheeling the companies to the right or left he formed at once a line of battle facing the enemy. Approaching the enemy with this formation, and when near him, he changed the direction of his march, making the flank-movement, protected by the advanced guard and hidden from view by some inequality of the ground. Then by a simple wheel of the companies his line of battle was formed, and was oblique to the general line occupied by the enemy. We find numerous instances of this maneuver recorded. At the battle of Lenthen he moved forward in four columns, the two interior ones being composed of infantry, and the exterior ones of cavalry. When he changed direction to make a flank-march, the four columns formed two, which by a wheel of the companies formed into two lines of battle. See *Flank-movement* and *March*.

FLANK-MOVEMENT.—This term has reference to the change of march of an army, or a portion of an army, which circumstances may necessitate, and which may occur when a battle is being fought, with the view to turning either one or both wings of the enemy, or a better position being taken up. In making a flank-movement before the enemy, it would be difficult to carry out the usual order of march as laid down for the march of an army to the *front*. Such a formation would be inconvenient to a large body of troops, if the ground or country were circumscribed or inclosed, having to march in one direction and to fight a battle in another, thus necessitating a long wheel of its columns before coming into action. To avoid this, a new order of march must be pursued.

On perfectly open ground such a movement might be accomplished by marching to a flank in order of battle; that is, in three columns formed of the two lines and the reserve, with an advanced guard protecting the flank towards the enemy. But the question is of making a march of this kind in an average broken or inclosed country, where very lengthened columns, especially of cavalry and artillery, could not without great risk offer their flank to the enemy. When a corps is moving thus to a flank, it will be of immense importance to decide whether it is to form line of battle to a front or a flank, relatively to the rest of the army and to the enemy. Thus Bülow's march to the field of Waterloo was a *flank-march;* but for the attack on the French flank, the order of march to a *front* was the proper formation for his columns.

The turning of the flank of a line of battle may be effected either by originally directing part of the army beyond that flank or by reinforcing one wing of a direct attack and deploying the added troops beyond the menaced flank during the engagement. The Prussians always seem to have operated in the latter way, engaging at the same time throughout the front. The history of the victories of the summer of 1870 is that the German corps march straight for the enemy, that the leading troops at once attack, that the rest hurry up to their support, extending and deepening the skirmishing line, and that, after a severe engagement, an extension beyond a flank renders the position untenable. See *Flank-marches.*

FLANK OF A BASTION.—In fortification, that part which unites the face to the curtain, comprehended between the angle of the curtain and that of the shoulder, and which is the principal defense of a place. Its use is to defend the curtain, the flank, and the face of the opposite bastion, as well as the passage of the ditch; and to batter the salient angles of the counterscarp and glacis, from whence the besiegers generally ruin the flanks with their artillery.

FLANK-PATROLS.—Besides the flankers proper, which constitute a portion of the movable advanced-posts, detachments of an independent character are sent out to patrol along the flanks of the main column. These should keep themselves in communication, by the suitable dispositions of vedettes, with the flankers. As the flank-patrols are frequently beyond direct supporting distance, they must adopt all the necessary dispositions against surprise of any other body marching independently; having their advanced-guard, etc., etc. These patrols keep on a level with their column; and particularly secure all lateral roads, or defiles, by which it might be suddenly attacked, until the column is beyond danger. A great activity, watchfulness, and caution should characterize this service. The officer in command of a flank-patrol must use his discretion in meeting an enemy, whether to attack him or to let him pass, if he has not himself been observed.

FLANKS OF A FRONTIER.—Certain salient points in a national boundary, strong by nature and art, and ordinarily projecting somewhat beyond the general line. The effect of these flanks is to protect the whole frontier against an enemy, as he dare not penetrate between, with the risk of their garrisons, reinforced from their own territories, attacking his rear, and cutting off communication between him and his base.

FLASH.—The flame which issues from any fire-arm or piece of ordnance on its being fired. *Flash in the pan* is an expression for the explosion of gunpowder without any communication beyond the vent.

FLASHING.—The proper incorporation of the ingredients of gunpowder is tested by *flashing;* that is, by burning a small quantity of the powder on a glass or porcelain plate. If any fine-grained powder, the quantity to be flashed is placed in a small copper measure, which is inverted over the flashing-plate. This provides for the granules being arranged in nearly the same kind of heap each time, which is important. The decomposition of the powder will be more thorough if the powder be thrown together in a small conical pile than if it be spread out in a thin layer on the plate; hence, for comparison of different powders, they should be placed on the plates as nearly as possible under the same conditions. If the powder has been thoroughly incorporated, the small charge placed on the plate will flash off when touched with a hot iron, leaving only smoke-marks on the plate. A badly incorporated powder will leave specks of undecomposed saltpeter and sulphur, forming a dirty residue. The flashing-test, though simple, requires experience and care to enable the observer to form an accurate judgment. A badly incorporated powder is easily detected; but to determine between two nearly alike, and both tolerably good, is vastly more difficult. Flashing should therefore be constantly practiced with all classes of powders, and it is advisable to keep samples of imperfectly incorporated grains to be flashed occasionally for comparison.

FLASK.—When casting a gun, the mold is formed in a case of cast-iron, called a *flask*, consisting of several pieces, each of which has flanges perforated with holes for screw-bolts and nuts, to unite the parts firmly. In casting the fifteen-inch gun, a circular flask is used, consisting of five upright sections, secured together by clamps fitting over flanges at either end of the sections; its thickness is one inch, and it is pierced with holes. The breech, or lower section, is made of sufficient length to cast the base of breech, cascabel, and square knob; the next above is twenty-five inches in length and cylindrical, being the part which embraces the cylinder of the gun; the next is the trunnion-section, fitted with trunnion-boxes having movable plates on their ends, that the trunnion-pattern may be placed and removed after the mold is finished; then there are two sections above this, the upper being about three feet longer than the required length of the gun, to admit of a "sinking-head." The entire length of the flask is twenty feet. See *Molding*

FLAT BASTION.—A bastion having its demi-gorges in the same straight line. See *Bastion*.

FLATS.—In ordnance, two vertical plane surfaces situated at equal distances from the axis of the bore. They serve to prevent the barrel from turning in the jaws of the vise when the breech-screw is taken out. See *Barrel*.

FLAW.—In casting or forging, any crack or opening which may be observed. In forging, it frequently occurs from bad welding. See *Casting*.

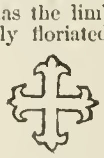
FLEAU D'ARMES.—An ancient offensive weapon; the part used for striking was armed with sharp iron spikes.

FLECHE.—In fortification, the most simple species of field-works; it is quickly and easily constructed, and therefore frequently used in the field. It usually consists of two faces forming a salient angle towards some object, from whence it cannot be approached on the prolongation of its capital. One simple rule for the construction of a flèche is to select a spot for the salient, and to throw up a breastwork on either side forming an angle of not less than 60 degrees, and allowing a distance of a yard to each file.

FLETCHER.—The name anciently applied to the man who made or repaired the military bows. He was also called *Bowyer*.

FLEUR-DE-LIS.—Authorities are undecided as to whether this celebrated emblem is derived from the white lily of the garden, or from the flag or iris, which, as generally represented, it more resembles both in form and color. "Ancient heralds," says Newton, "tell us that the Franks of old had a custom, at the proclamation of their king, to elevate him upon a shield or target, and place in his hand a reed or flag in blossom, instead of a scepter; and from thence the kings of the first and second race in France are represented with scepters in their hands like the flag with its flower, and which flowers became the armorial figures of France." However this may be, or whatever may be the value of the other legendary tales, such as that a blue banner, embroidered with golden fleur-de-lis, came down from heaven; that an angel gave it to King Clovis at his baptism, and the like; there can be little doubt that, from Clovis downwards, the kings of France bore as their arms first an indefinite number, and latterly three golden lilies on a blue field, or, as heralds would say, azure, three fleur-de-lis, or. It was Charles VI. who reduced what had hitherto been the indefinite number of fleur-de-lis to three, disposed two and one; "some conjecture upon account of the Trinity, others say to represent the three different races of the kings of France." Many English and Scotch families bear the fleur-de-lis in some portion of their shield, and generally with some reference to France.

FLEURY—FLORY.—In Heraldry, signifying that the object is adorned with fleurs-de-lis; a cross-fleury, for an example, is a cross the ends of which are in the form of fleurs-de-lis. There are several varieties in the modes of representing these crosses which has led to distinctions being made between them by heralds too trivial to be mentioned; but they are all distinguishable from the cross-potance, or potancée, incorrectly spelled patonce by English heralds. In the latter the limbs are in the form of the segments of a circle, and the foliation is a mere bud; whereas the cross-fleury has the limbs straight and the terminations distinctly floriated. Perhaps the most cele-



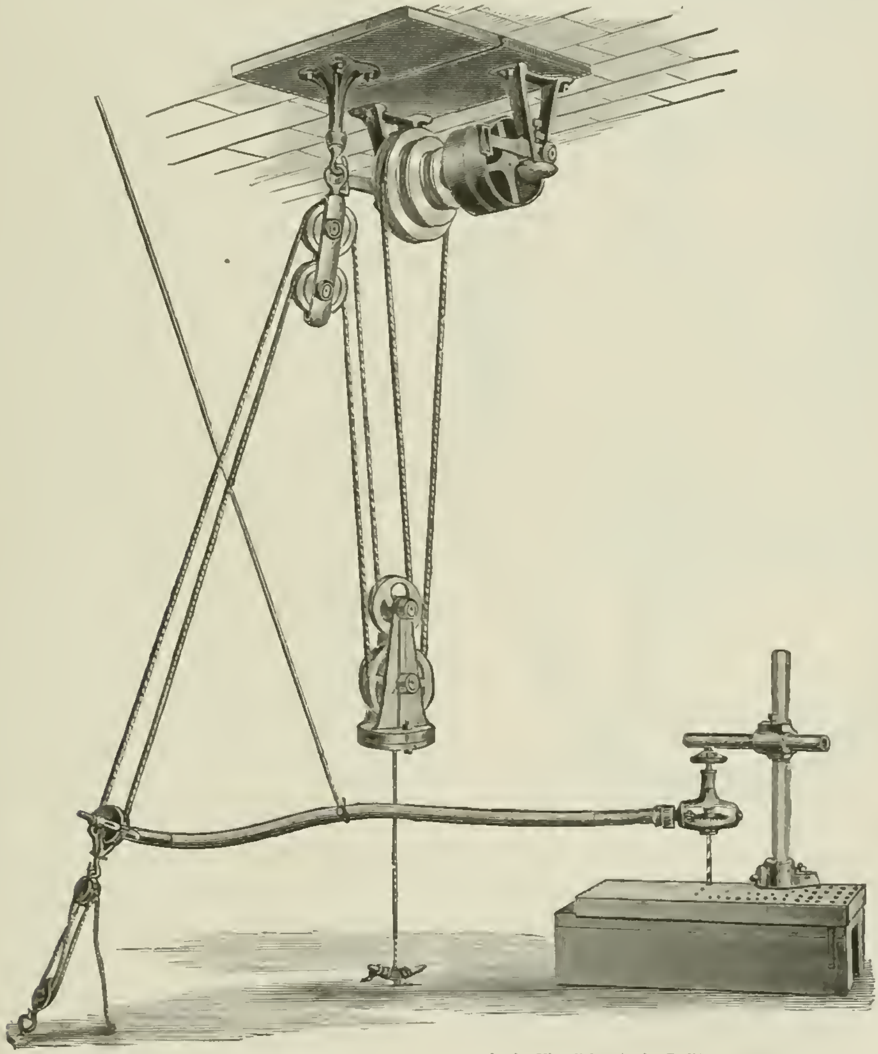
Cross-fleury.

Cross-potance.

brated instance of this bearing is in the case of the double prepuce flowery and counter-flowery gules which surrounds the red lion in the Royal Arms of Scotland, and which Charlemagne is said to have conferred on Achaius, King of Scotland, for assistance in his wars. The object, according to Nisbet, was to show that, as the lion had defended the lilies of France, these "hereafter shall continue a defense for the Scots lion, and as a badge of friendship, which has still continued." That the lilies were assumed in consequence of the intimate relation which prevailed between France and Scotland for so many generations will not be doubted; but the special occasion of the assumption may not be admitted in our day to be quite beyond the reach of skepticism, notwithstanding Nisbet's assertion that it is so fully instructed by ancient and modern writers that he need not trouble his readers with any long catalogue of them. Also written *Flowry* and *Fleurette*.

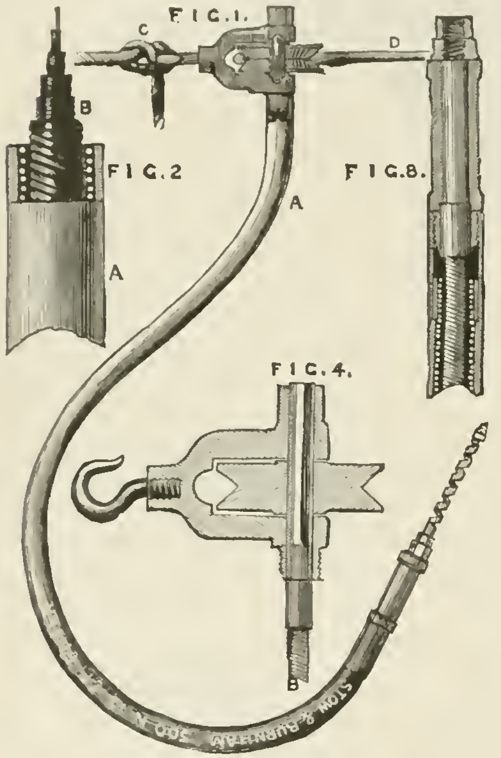
FLEXIBLE SHAFT.—An apparatus for transmitting rotary motion to any desired distance from the power source through any number of curves; thus allowing the power to be carried to the work, instead of the work to the power. The uses of the shaft in the arsenal and in engineering are almost unlimited, and as it is readily handled, easily cared for, and durable, it is rapidly becoming a staple article where work is to be done by power. The construction of the flexible shaft is peculiar to itself, and it is in this peculiar construction that its utility consists. It is made up of a series of coils of steel wire, wound hard upon each other, each alternate layer running in an opposite direction, and the number of wires in the different layers varying according to the work the shaft is adapted to; on being brought to size, about one inch at each end of the shaft is brazed solid, and to these solid ends the fittings are attached, the one to receive the tools to be operated, the other to receive the power from the pulley inclosing it, which in turn receives its power from a belt. Next a case is prepared consisting first of a single coil of steel wire, its internal diameter being a loose fit for the outside of shaft; this is covered with some flexible material, leather preferably, over which at either end a ferrule is fastened; into this ferrule at one end is screwed the hand-piece; at the opposite end the frame which carries the pulley.

The drawings show all the details of construction. Fig. 1 represents the complete shaft with the auger screwed into the end. Fig. 2 shows the manner of "laying up" the shaft, and the construction of the case. Fig. 3 is a section showing the hand-piece, shaft-case, and end-nut to which are attached the tools to be used. Fig. 4 is a section at the pulley end. Letter references: AA, shaft-case; B, sections of shaft and case; C, cord to draw pulley to any desired direction; D, driving-belt. This mode of construction insures stability, durability, and very great torsional strength; and at the same time perfect flexibility at right angles to the axis.



Round-about Transfer, combined with Countershaft, Flexible Shaft, Drill-press, etc.

In the above drawing is shown the round-about transfer, in connection with the countershaft, flexible shaft, drill-press, etc. The lower pulley takes up the slack of the driving-rope, and the swiveled pulleys at the top allow the shaft to be carried in any direction. A peculiar feature of this device, distinguishing it from all others of its class, is the fact that the rise of the lower pulleys is only one half the extension of the driving-rope, a matter of great importance in a low-studded room. With the roundabout work may be performed at varying distances from the fixed countershaft and in any desired direction. Besides metal drilling, the shaft is admirably adapted to the kindred work of tapping, reaming, and boring. The convenience of the flexible shaft is wonderfully shown in bridge-work. There are always multitudes of holes to be drilled about bridges when in construction, and the shaft will allow of many times the amount of work in the same period of time. Engineers are now beginning to specify in their specifications that all rivet-holes must be punched smaller and reamed out to a perfect circle, thus insuring a round bolt where it is intended to be. Some bridge-works are already using these shafts with marked success. In building carriages and wagons there are always great quantities of holes to be bored and drilled both in the wood and iron about the shafts and carriage-body; and this is a place where the utility of the flexible shaft is admirably shown.



Details of Flexible Shaft.

One man with a shaft and chuck with drill can do as much in an hour as has heretofore been done by hand in three or four hours. For the purpose of horse and cattle brushing the shaft is frequently used, driven by steam or other power. The brush is made in the most thorough and careful manner, and is so guarded that it cannot catch in the tail or mane of the animal. Not only is the tedious operation of cleaning horses greatly expedited by this machine, but the work is more thoroughly done than is possible in the most careful hand-grooming. The expense of finishing irregular metal dies for stamping, also the various molds, may be greatly lessened by using the shaft. Round and pear-shaped files of various sizes are used, also small emery-wheels of appropriate pattern. See *Drilling-machine.*

FLIGHT.—1. A word employed figuratively for the swift retreat of an army or any party from a victorious enemy. It is likewise applicable to missile weapons or shot; as a flight of arrows, a flight of bombs, etc. 2. In gunnery, the flight of a shot or shell is the time during which it is passing through the air from the piece to the first graze.

FLINT IMPLEMENTS AND WEAPONS.—Weapons, believed to have been used by the primitive inhabitants, have from time to time, in more or less number, been turned up by the plow and the spade, dug out from ancient graves, fortifications, and dwelling-places, or fished up from the beds of lakes and rivers, in almost every country of Europe. They do not differ, in any material respect, from the flint implements and weapons still in use among uncivilized tribes in Asia, Africa, America, and the Islands of the Pacific Ocean. The weapons of most frequent occurrence are arrow-heads, spear-points, dagger-blades, and axe-heads or celts. The more common implements are knives, chisels, rasps, wedges, and thin curved or semicircular plates, to which the name of "scrapers" has been given. There is great variety as well in the size as in the shape, even of articles of the same kind. There is equal variety in the amount of skill or labor expended in their manufacture. In some instances the flint has been roughly fashioned into something like the required form by two or three blows; in others it has been laboriously chipped into the wished-for shape, which is often one of no little elegance. In yet another class of cases, the flint, after being duly shaped, has been ground smooth, or has even received as high a polish as could be given by a modern lapidary. Examples of all the varieties of flint weapons and implements will be found in the British Museum, in the Museum of the Royal Irish Academy at Dublin, in the Museum of the Society of Antiquaries of Scotland at Edinburgh, and above all in the Museum of the Royal Society of Antiquaries at Copenhagen, which is especially rich in this class of remains.

Geological discoveries have recently invested flint implements with a new interest. At Abbeville, at Amiens, at Paris, and elsewhere on the Continent, flint weapons, fashioned by the hand of man, have been found along with remains of extinct species of the elephant, the rhinoceros, and other mammals, in undisturbed beds of those deposits of sand, gravel, and clay to which geologists have given the name of "the drift." They so far resemble the flint implements and weapons found on the surface of the earth, but are generally of a larger size, of ruder workmanship, and less varied in shape. They have been divided into three classes—round-pointed; sharp-pointed; both being chipped to a sharp edge, so as to cut or pierce only at the pointed end; and oval-shaped, with a cutting edge all round. The first and second classes vary in length from about 4 inches to 8 or 9 inches; the third class is generally about 4 or 5 inches long, but examples have been found of no more than 2 inches, and of as much as 8 or 9 inches. In no instance has a flint implement yet discovered in the drift been found either polished or ground. The French antiquary, M. Boucher de Perthes, was the first to call attention to these very interesting remains, in his *Antiquités Celtiques et Antédiluviennes.* But it has since been remembered that implements of the same kind were found in a similar position at Hoxne, in Suffolk, along with remains of some gigantic animal, in 1797, and at Gray's Inn Lane, in London, along with remains of an elephant, in 1715. Both these English examples are still preserved,—the first in the Museum of the Society of Antiquaries at London, the second in the British Museum,—and they are precisely similar in every respect to the examples more recently found in France.

To what age these remains should be assigned is a question on which Geology seems scarcely yet prepared to speak with authority. But, in the words of Mr. John Evans in his essay on "Flint Implements in the Drift," in the *Archæologia*, "thus much appears to be established beyond a doubt, that in a period of antiquity remote beyond any of which we have hitherto found traces, this portion of the globe was peopled by man; and that mankind has here witnessed some of those geological changes by which the so-called diluvial beds were deposited. Whether these were the result of some violent rush of waters, such as may have taken place when "the fountains of the great deep were broken up, and the windows of heaven were opened," or whether of a more gradual action, similar in character to some of those now in operation along the courses of brooks, streams, and rivers, may be matter of dispute. Under any circumstances, this great fact remains indisputable, that at Amiens, land which is now 160 feet above the sea, and 90 feet above the Somme, has, since the existence of man, been submerged under fresh water, and an aqueous deposit from 20 to 30 feet in thickness, a portion of which, at all events, must have subsided from tranquil water, has been formed upon it; and this, too, has taken place in a country the level of which is now stationary, and the face of which has been little altered since the days when the Gauls and the Romans constructed their sepulchers in the soil overlying the drift which contains these relics of a far earlier race of men." See *Elf-arrow-heads*.

FLINT-LOCK.—A very modern firelock, invented about 1635. It was suggested, no doubt, from the snaphaunce, and from which it only differed by the cover of the pan forming part of the steel or hammer, which retained its furrows until the eighteenth century. Before the invention of the *flint-lock*, the wheel-lock was frequently called the firelock. It does not appear to have been employed in England until 1677.

FLISSA.—An Oriental sword without a hilt or cross-guard. The handle is straight and forms with the blade a Latin cross.

FLO.—An ancient name for an arrow used in war. Seldom used at present.

FLOAT.—The wooden cover of the *sponge* or *tar-bucket* used with field-gun carriages.

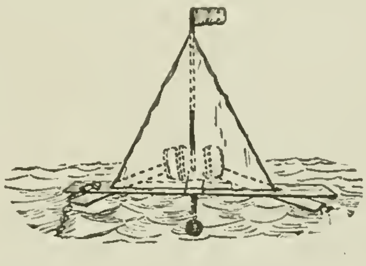
FLOATING BATTERY.—A hulk very heavily armed, made as invulnerable as possible, used in defending harbors, or in attacks on marine fortresses. The most remarkable instance of their employment was by the French and Spaniards against Gibraltar, in the memorable siege which lasted from July, 1779, to February, 1783, when ten of these vessels, carrying 212 large guns, were brought to bear on the fortress; they had sides of great thickness, and were covered with sloping roofs, to cause the shot striking them to glance off innocuously. But their solidity and strength were unavailing against the courage and adroitness of the defenders, under the gallant General Elliot, who succeeded in destroying them with red-hot cannon-balls. Steam floating batteries of iron were constructed for the war with Russia in 1854, both by the British and French governments; but, notwithstanding that they rendered good service before Kinburn, they have since been generally discarded for other than purely defensive purposes, as too cumbrous for navigation, and too suffocating from the smoke that collected between their decks during action. Indeed, vessels of this class may be regarded as having been superseded for all purposes both of attack and defense by the newer kinds of gunboats and armor-clad frigates, as well as by the turret-ships, which are among the more recent contrivances of skill in naval engineering.

FLOATING BRIDGE.—A variety of double bridge, the upper one projecting beyond the lower one, and capable of being moved forward by pulleys, used for carrying troops over narrow moats in attacking the outworks of a fort. See *Flying Bridge*.

FLOATING DERRICK.—A mechanical contrivance used for the same purposes as the crane, but recently so improved in size, strength, and mechanism as to be able not only to raise a body of 1000 tons in weight, but to transport it from one place to another. The following description of the *Great Floating Derrick*, built in 1859, will convey an idea of the powers of this machine, and of the principles upon which it works. This derrick was built by the Thames Iron Ship-building Company, at Blackwall. It consists of a flat-bottomed vessel, 270 feet long, and 90 feet across the beam, and is divided throughout into a number of water-tight compartments, which can be filled so as to counterbalance any weight on an opposite side. From the deck of this floating steam crane rises an iron tripod 80 feet high, on the top of which revolves a gigantic boom, 120 feet long, and above the boom the "king-post," a continuation of the tripod, rises to the height of 50 feet. One arm of the boom is furnished with ten fourfold blocks; the chains attached to these blocks are all passed across the king-post, brought over the other arm of the boom, and so descend to the other side of the vessel, where they are connected with two powerful steam engines, by means of which the weights are raised. This derrick is capable of being propelled by means of a series of bucket-paddle floats at the rate of 4 miles an hour. It is the invention of Mr. Bishop, an American. Derricks have been long in use in America, and have proved much more expeditious and economical than any other species of lifting-power. They are chiefly used for lifting machinery or other great weights, and for raising wrecks. See *Cranes*.

FLOATING RAVES.—A light open frame of horizontal bars, attached along the top of the sides of wagons, and sloping upwards and outwards from them. They are very convenient for supporting and securing light bulky loads.

FLOATING TARGET.—The best and most readily constructed target is composed of three stout boards twelve feet long and a foot broad, forming a triangle. A fourth board extends from one of the angles to the middle of the opposite side. The whole is fastened together with spikes, or, better, with screw-bolts. At the center of the triangle, a hole is cut in the last-mentioned board; this hole is about four inches in diameter; through it passes a pole projecting about twelve feet above and three feet below. A 10-inch shot, or equivalent weight, is secured to the lower end of the pole, and rope guys are led from the top to the angles of the platform to keep the pole upright. To these ropes are fastened triangular pieces of canvas. A bull's-eye four feet in diameter is painted on the middle of this screen, upon each side. On each side of the pole, underneath the platform, an empty water-



tight barrel is lashed to the athwart-board, and a small red flag is placed on the top of the pole. This target is suitable for even the roughest water. To hold it, under such circumstances, requires an anchor weighing not less than two hundred pounds. This is attached to the target by a chain or heavy rope, secured to one angle of the base by an eye on the under end of the bolt holding the planks together. When a single anchor is used, the chain or rope is liable to wind itself around and trip the anchor, causing it to drag. To obviate this, it is advisable to moor the target with two anchors, placed in the direction of the current. The distance of the anchors apart must depend upon the depth of the water, and should be such as to form, with the mooring-chains, about an equilateral triangle.

An empty water-tight barrel, painted some dark color, forms a good target or point at which to aim. The cask is secured in position by means of a small anchor or a kedge attached to it by a stout rope fastened to secure lashings on the cask. Instead of an anchor, any heavy body, such as a stone or bars of iron, may be used. If the current is swift, the weight should never be less than the flotation of the cask. This latter is obtained by multiplying the number of gallons contained in the cask by ten—the approximate weight of a gallon of water. A spar, similar to the spar-buoys to be seen about harbors, forms a good target and one of easy construction. When a spar or cask is used, a small flag of some bright-colored stuff, attached to the target, makes it more conspicuous and easy to aim at. The target is moored in position at the commencement of the season's firing, and is left out until the firing is completed. Its distance from the two *stations* and from the gun is determined by ordinary trigonometrical methods, or by plotting from plane-table observations. After the table is set up at its station and adjusted, the officer in charge marks upon it the line to the target, to the gun, and to the other station. These lines form the basis for the subsequent plotting of the shots. The officer at each station is accompanied by a flagman to signal to the piece whether the shots are *short* or *over*. By this means the error, for all subsequent shots, is approximately corrected.

The officer in charge of the firing attends to the loading and aiming, sees that the charges and projectiles are weighed, and that the pressure-plug (when used) is properly attached to the cartridge; also that the fuses for the shells are of the proper length. When everything is in readiness, he directs his signal-flag to be raised to inform the observers at the stations that he is about to fire. The piece is then discharged. The other officers at the battery attend to the stop-watch and telemeter. When the gun is fired, the officer at each station, sighting through the alidade, catches the point on the water where the shot strikes, or, in case of a shell, the point in the air where it explodes. He then draws a fine line to mark the direction, and gives it a number corresponding with the number of the shot. The observations thus obtained are plotted. A suitable scale is assumed (one of 1 inch to 100 yards is convenient), and the line joining the two stations is laid off on the plotting-sheet according to the scale. From this all the other lines are laid off, usually by the method of chords. The intersection of the lines to the target establishes its position, and those to the gun its position also. The distance from the gun to the target is ascertained from the scale. The lines of observation to each shot having been carefully numbered by the observers at the plane-tables, the intersection of corresponding numbers on the plot gives the striking-points of the shots or bursting-points of the shells. See *Artillery-practice* and *Target*.

FLOATING WAREHOUSES.—The danger that attends the storing of petroleum and other inflammable and explosive chemicals has led in France to the construction of warehouses, storehouses, or magazines that will float in a dock or basin, and can be moored at a distance from buildings on land. So far as concerns England, an Act of Parliament was passed in 1866 relating to the carriage and storing of dangerous substances; this law was amended and considerably extended by an Act passed in 1875, applying to gunpowder and other explosive substances (including nitro-glycerine, dynamite, gun-cotton, blasting-powders, fulminate of mercury, fire-works, percussion-caps, etc.). This Act requires such substances to be marked "gunpowder" or "explosive," and to be conveyed or stored with special precaution; it leaves much power to the Secretary of State to intervene in special cases and arrange the precise conditions. The storing of petroleum is regulated by the Act of 1871. In France, as we have said, floating warehouses have been constructed, two being finished in 1864, and others added in later years. The construction of the floating fabrics is remarkable. Each warehouse or magazine consists essentially of one hundred hollow iron cylinders, arranged in four rows of 25 each, firmly lashed or strapped together to form a kind of raft. Each cylinder, 16 feet long by 6 or 7 in diameter, has hemispherical ends, with a man-hole at one end. They are placed upright when in position, so as to be filled with petroleum, glycerine, gunpowder, or any other substance, through the man-hole. As they will hold 25 tons each, their united capacity is 2500 tons. There is a wooden covering to the top of the collected mass of cylinders, and round the sides as far down as the line of flotation, to shield the iron from fluctuations of temperature. This covering is made of thick planking, fastened to the cylinders by angle-irons which have been riveted to the latter. At the head and stern are large hawser-holes, to admit hawsers for towing and mooring the floating fabric, bringing it into and taking it out of a basin or dock, and warping it to a quay or dock wall: or, when the vessel is moored in the middle of a basin, far away from buildings, a barge may deliver or receive the dangerous cargo, and thus the vessel may be kept altogether away from quays and wharves.

FLOGGING.—Corporal punishment has existed from time immemorial in the British army and navy; formerly having been inflicted upon slight occasion, and often with barbarous severity. In deference, however, to public opinion, it has been much less resorted to during recent years, and promises almost to disappear under a regulation of 1866. A man must now be convicted of one disgraceful offense against discipline before he can be liable to flogging for the next such offense; and even after one such degradation, he may be restored to the non-liable class by a year's good conduct. The punishment of flogging, which is generally administered with a whip or a "cat" of nine tails on the bare back, cannot, under existing rules, exceed fifty lashes.

Corporal punishment is never recognized in the French army; but then the soldiers in that country are drawn by conscription from all ranks of society, and have, on an average, a higher moral tone than the British recruits, who, attracted by a bounty, volunteer usually from the lowest orders. On the other hand, the discipline in the French army, and especially during war on a foreign soil, is universally admitted to be inferior to the strict rule preserved among British troops. Soldiers and sailors being men unaccustomed to control their passions, and any breach of insubordination being fatal to the *esprit* of a force unless summarily repressed, it is considered necessary to retain the power—however rarely exercised—of inflicting the painful and humiliating punishment of flogging. The French soldier, though escaping the ignominy of personal chastisement, is governed by a code harsher than our Articles of War as actually administered; and the punishment of death, scarcely known during peace, is not unfrequently visited in France upon offenders against discipline.

The practice of flogging was long ago discontinued by the United States Government. It may be noted, however, that under the statutes of one State (Delaware) it exists as a punishment for petty crimes.

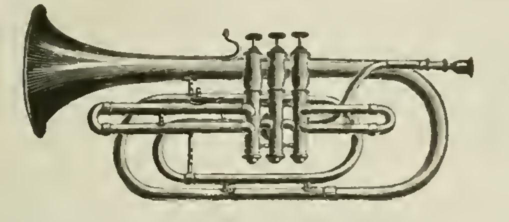
FLOODGATE.—In fortified towns, a structure composed of two or four gates, so that the besieged by opening the gates may inundate the environs so as to keep the enemy out of gun-shot.

FLOTANT.—A term employed in Heraldry to express that the object is flying in the air as, for example, a banner-flotant. See *Heraldry*.

FLOURISH.—1. To execute an irregular or fanciful strain of music, by way of ornament or prelude; as, a *flourish of trumpets*. 2. The waving or brandishing of a weapon.

FLOURISH OF TRUMPETS.—The sounding used by regiments having no bands in receiving a General Officer on parade, viz., by the trumpets or bugles sounding the "flourish."

FLUGELHORN.—The introduction of the flügelhorn into bands in this country is of comparatively recent date, though in the larger bands of Europe the very pleasing effect of this instrument is generally recognized, and is in consequence commonly used. Its key is B flat, and in size it is between the B*b* cornet and E*b* alto. It usually takes the parts given the 3d and 4th B*b* cornets, perfecting the harmony at this point where it is often weak. It can also be used with very pleasing results in certain solo parts and cadenzas, or in duos with the cornets. In fact, the flügelhorn to a band is what a French horn is to the orchestra. A band of 12 or 14 pieces should include



at least one, and of 15 to 20 pieces two of these horns. The drawing shows the E♭ alto, bell front.

FLUGELMAN.—The leader of a file; the one who stands in front of a body of soldiers, and whose motions in manual exercise they all simultaneously follow. Also written *Fugelman*.

FLUSHED.—A term frequently applied when men have been successful, as in the expression *flushed with victory*.

FLUTE.—This wind-instrument, so frequently used in military bands and so well known to the ancient Greeks, has a soft and pleasant quality of tone. It is commonly made of boxwood or ebony, but sometimes of ivory or silver. Its form is that of a taper tube, formed in four pieces, with six holes for the fingers, and with from one to fourteen keys, which cover or open other holes. The sound is produced by blowing from the mouth into the embouchure, an oval kind of hole at one side of the thick end, which is done by the lips covering a part of the hole, so that the air in its passage from the mouth is broken against the opposite edge of the hole, which causes the column of air inside the tube to vibrate. The notes of the gamut are produced by the opening or shutting of the holes by the fingers of both hands. The compass of the flute is from D to A sharp, nineteen diatonic intervals. For solo-playing, the flute with a compass from G to C is sometimes used. For orchestral purposes there are also the *tierce* flute, the octave flute, the E flat and F piccolo flute; and the highest of all, the C piccolo. Improvements on the flute have been made from time to time by Quantz, Ribock, Trommlitz, and especially by Böhm in Germany, and by Rudell and Rose in London.

FLUX.—The term given to the substances employed in the arts which cause or facilitate the reduction of a metallic ore and the fusion of the metal. *White flux* is an intimate mixture of 10 parts of dry carbonate of soda and 13 parts of dry carbonate of potash, and is mainly instrumental in withdrawing the silica or combined sand from mineral substances; *black flux* is prepared by heating in close vessels ordinary cream of tartar (bitartrate of potash), when an intimate mixture of finely divided charcoal and carbonate of potash is obtained. The latter flux, when mixed with finely divided metallic ores, and the whole raised to a high temperature in a furnace, is not only useful in removing the silica, which the carbonate of potash it contains enables it to do, but the charcoal withdraws the oxygen from the metallic oxide and causes the separation of the pure metal. Limestone is employed as the flux in the smelting of iron ores. The other fluxes are fluor spar, borax, protoxide of lead, etc. See *Iron*.

FLUXIONS.—The method of fluxions invented by Newton was intimately connected with the notion of velocity uniform and variable; and extended that notion, derived from the consideration of a moving point, to every species of magnitude and quantity. It proposed to determine in all cases the rate of increase or decrease of a magnitude or quantity whose value depends on that of another, which itself varies in value at a uniform and given rate. If x and y represent two such quantities, and $y = F(x)$ represent the law of their dependence, and if x be supposed to be the velocity with which x increases, and $\dot{y}$ that with which y changes value. Newton undertook by his method to express $\dot{y}$ in terms of $\dot{x}$ and of x, or to find $\dot{y} = F_1(x) . \dot{x}$. The quantities x and y, which in modern language we call the variables, he called *flowing* quantities or *fluents*, and $\dot{x}$, $\dot{y}$, which we should represent by dx and dy, and call differentials, he called the *fluxion* of x and y. See CALCULUS. To illustrate his notation: Suppose $y = x^n$, it may be shown that $\dot{y} = nx^{n-1}\dot{x}$. Regarding now $\dot{y}$ as a quantity depending on x and $\dot{x}$, and supposing x to increase uniformly, in which case $\dot{x}$ is constant, and $\overset{+}{(\dot{x})}$ its fluxion zero, we observe that $\dot{y}$ may have a fluxion, for it depends on the value assumed by $nx^{n-1} . \dot{x}$, when x further changes. We find $\overset{+}{(\dot{y})} = n . (n-1) . x^{n-2} . (\dot{x})^2$. Thus, second fluxion or velocity of $\dot{y}$, or $\overset{+}{(\dot{y})}$, Newton wrote $\ddot{y}$. If x had a second fluxion, or did not change uniformly, then that fluxion he wrote $\ddot{x}$. The third fluxion of y he wrote $\dddot{y}$; and so on, pointing as many points over the fluent as there are units in the order of the fluxion. For the fluent he had no special symbol. Instead of $\int nx^{n-1}\,dx = x^n$, according to the modern notation, he wrote $\underline{nx^{n-1} . \dot{x}}|$, putting the expression in an inclosure. Imagine a point to move uniformly in the direction of a fixed line, and, at the same time, to have a variable transverse motion depending upon a law which determines the character of the curve or line thus generated. The indefinite part of the curve up to any point is the *fluent*, and the exceedingly small element of the curve that is generated in the next infinitesimal, but constant, period of time is the *fluxion*. These are both variable except in the case of straight lines. Passing from the consideration of the motion of a point in a plane to that of a point in space, it is evident that the generating point will describe a straight line, or a curve of single or double curvature. Equations can be constructed formulating laws of motion which will cause the general point to trace any curve whatever, and from these equations the natures of the curves can be discovered. The science of fluents and fluxions is based upon the above principles. Any plane figure can be generated by the motion of a straight line, and any volume by the motion of a plane figure. In all cases, the portion of a plane figure or volume generated in the time t is the fluent, while that generated in the time dt is the fluxion. In practice, the method of integrals and differentials has superseded the system of fluents and fluxions, chiefly because the notation of the latter is too cumbersome.

FLY.—The length of any flag. The dimension at right angles to the staff, the other dimension being the *hoist*. The term is also applied to the outer canvas of a tent. See *Tent*.

FLYING ARMY.—A strong body of cavalry and infantry which is always in motion, both to cover its own garrisons and to keep the enemy in continual alarm. The *flying artillery* is also trained to very rapid evolutions.

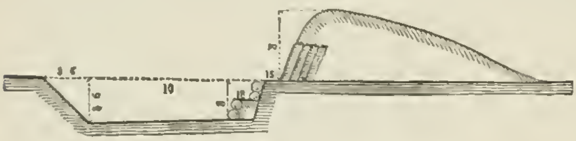
FLYING BRIDGE.—A flying bridge is an arrangement by which a stream with a good current may be crossed when, from a want of time or a deficiency of materials, it may not be possible to form a bridge. It consists of a large boat or raft firmly attached by a long cable to a mooring in the center of the stream, if the channel be straight, or on the bank, if the channel be curved. By hauling the boat or raft into proper positions, it will be driven across the stream in either direction as may be desired. The bridge is made usually of two, three, and sometimes six boats, connected together and very solidly floored over, the beams being fastened to the gunwales of the boats with iron bolts or bands, and the flooring-planks nailed down upon them. The floor is sometimes surrounded with a guard-rail. The most suitable boats are long, narrow, and deep, with their sides nearly vertical, in order to offer greater resistance to the action of the current. At the end of the rope is fixed an anchor which is moored in the channel, if this is in the middle of the stream. If the channel is not in the middle, the anchor is placed a little on one side of it towards the more distant shore. By means of the rudder, the bridge is turned in such a direction that it is struck obliquely by the current, and the force resulting from the decomposition of the action of the current makes it describe an arc of a circle around the anchor as a center, and this force acquires its maximum effect when the sides of the boats make an angle of about 55° with the direction of the current. See *Bridges* and *Trail-bridge*.

FLYING CAMP.—A camp or body of troops formed for rapid motion from one place to another.

FLYING COLORS.—Colors unfurled and left to wave in the air. Hence, *to return or come off with flying colors* is to be victorious, or to succeed in any undertaking.

FLYING PARTY.—A detachment of men employed to hover about an enemy and observe his movements.

FLYING SAP.—In all siege-operations, when the trenches have been pushed forward to within destructive range of case-shot, the construction by the simple trench has to be abandoned, and one which will afford more speedy shelter resorted to. This is effected by placing a row of ordinary gabions in juxtaposition along the direction of the trench; these being filled with the earth from the trench, the parapet is completed by throwing the remaining earth over and beyond them. This process is termed the flying sap, from the rapidity with which the work is



Section of Parallel with Flying Sap.

done. It is also executed by troops of the line, each man bringing two gabions on the ground, which he is required to fill, and also to complete the portion of the trench, in the rear of them, assigned to the relief to which he belongs. The requisite height is given to the parapet either by heaping up the earth above the top of the gabions, or by placing three ordinary fascines upon the gabions, two being in the bottom course and the other on top, and throwing up the earth at least as high as the top fascine. In positions where the earth cannot be obtained in sufficient quantity to afford a speedy cover, as in a shallow stratum of soil on rock, etc., two rows of gabions, placed in juxtaposition, may be used for the flying sap. The troops for constructing both this and the simple trench are divided into three parties or reliefs. The first digs the trench to the requisite depth and to the width of 5 feet. The second widens it 4 feet 6 inches. The third finishes what remains, giving the requisite slopes to the front and rear. See *Sap*.

FLYING-SHOT.—A shot fired at any object in motion, as a horseman, or a ship under sail, etc. The term is also applied to the marksman who fires thus.

FLYING-TORCH.—An important article of signal-equipment. This torch is attached to a long staff, and is used in night-signaling.

FLY-WHEEL.—A heavy wheel attached to machinery to equalize the movement. By its inertia it opposes any sudden acceleration of speed, and by its momentum it prevents sudden diminution of speed; in the latter case it acts as a store of power to continue the movement when the motor temporarily flags, or in passing dead-centers when the motor is inoperative. In the Cummer engine, when the fly-wheel is used, instead of having heavy weights moving back and forth with a variable velocity, there is a wheel with a heavy rim revolving continuously in the same direction with great velocity and thus storing up a large amount of energy. The work done by the steam at the commencement of a stroke, in excess of the mean work, is so small compared with the energy stored in the fly-wheel, that no great increase in velocity can take place: the fly-wheel simply absorbs the excess without a perceptible increase of speed. A similar state of things exists at the latter part of a stroke, when the steam-pressure has rapidly fallen and less work is done; the fly-wheel then yields up a part of its energy to supply the deficiency and still does not visibly retard its speed. The varying effort of the crank-pin and the varying resistance of the load are also met in the same way, and the result is to approximate very closely to a uniform tangential pressure upon the crank-pin, with only very slight variations in the velocity of the fly-wheel. Just at this point comes in the office of the governor, for the slightest change of speed is instantly met by a change in the point of cut-off and standard speed restored. But it is important to have a fly-wheel so proportioned that it does not admit of any sudden or a great change of speed. If the rim is not heavy enough, any slight change of pressure or load causes considerable change of speed, and when the governor acts to correct this there is caused a variation in the other direction; thus with a sensitive governor and a light fly-wheel there is a continual and quite unnecessary fluctuation of speed. This does not occur with such a weight of rim as the fly-wheels of the Cummer engine have; with them the permissible variation from standard speed is very small, and the governor is depended upon for the rest of the regulation.

As a matter of interest in connection with fly-wheels, we have made a diagram which shows the variations of power, above and below the mean work done in a revolution, with a steam-pressure of 90 lbs. and a cut-off of $\frac{1}{5}$ stroke. The mode of constructing this diagram is very simple and it may be briefly explained:

We constructed an ideal diagram, such as Fig. 1, for steam at 90 lbs., cut-off at $\frac{1}{5}$ stroke, and then expanded to the end. The length of the diagram representing the stroke, we may construct a semicircle upon this line and divide the half-circumference into equal parts, representing successive positions of the crank; if the connecting-rod be infinitely long, lines drawn from these points, at right angles to the base-line, will give the corresponding positions of the piston, and, being ordinates of an indicator-diagram, will show by their length the pressure upon the piston for each of these positions of the crank. These

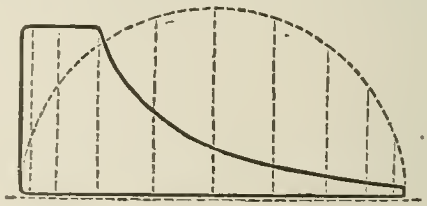


Fig. 1.

pressures, however, are not just those which propel the crank; it is the tangential pressures upon the crank which we desire to have; these are different for each angle of the crank with the line of centers; and, since in practice the connecting-rod has a definite length, its modifying influence must be allowed for. We made then a table of tangential pressures for forty equal divisions of the circle, supposing the radius to represent a pressure of one pound per square inch on the piston, and allowed for a connecting-rod of six cranks' length. Then from the diagram were found the effective steam-pressures corresponding to each crank-position, which, multiplied by the tangential crank-pressures for one pound pressure on the piston, gives the tangential pressure for each division, with 90 lbs. initial steam-pressure, and the various effective pressures for successive points as taken from the diagram. Referring to Fig. 2, the inner circle has a diameter equal to the length of the diagram, and it is subdivided into a number of equal parts, and radial lines are drawn extending beyond the cir-

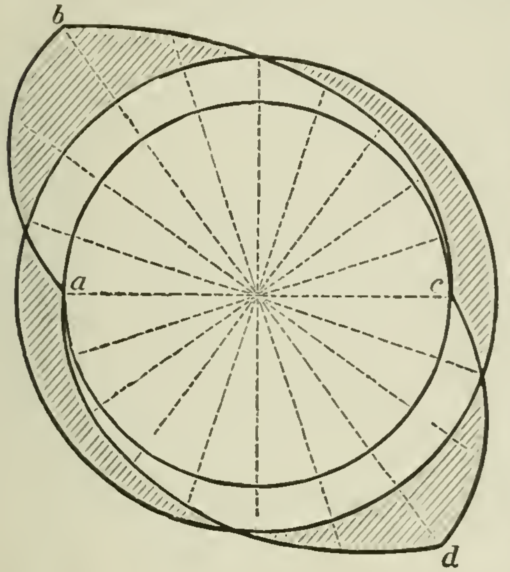


Fig. 2.

cle; upon each line is laid off the corresponding tangential pressure, and the extremities joined by a line makes the curve *a b c*, starting from *a*, where the pressure is 0, and ending at *c*, where the pressure is also 0. The return-stroke gives a corresonding curve, *c d a*. We now find the mean tangential pressure, which is, of course, the average of all these other pressures, and represent it by the outer circle. It will be seen that the area inclosed between the two circles represents the work done in a revolution; also that the sum of the areas included between the two curves *a b c*, *c d a* and the inner circle represents the same work. These two curves cross the circle of mean pressure, a part of the curve being above and a part below the line; for that part of a revolution where the curve extends above the circle the work is in excess, and for that portion where the curve goes below there is a deficiency of work done. Two phases of a revolution show an excess, and two phases a deficiency, and the excess balances the deficiency for an entire revolution, as we find on calculating the areas. Comparing the whole excess or deficiency with the work done in a revolution, which is represented by the mean pressure upon the crank-pin, exerted through 360°, or the complete circle, we find a variation of 37.5 per cent for a whole revolution. If we take the greatest area, which is the excess during the first quadrant, and compare it with the work for a stroke, or a half-revolution, we will have a variation of 45.4 per cent. See *Steam-engine*.

FOCUS OF EXPLOSION.—The center of the chamber of a mine. See *Crater* and *Mines*.

FOCUS OF IGNITION.—The point at which the powder-hoses or the *saucissons* are brought together when several mines are to be fired simultaneously.

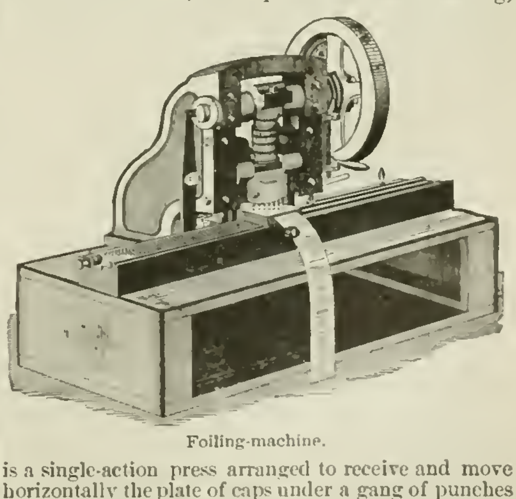
FODDER.—The food collected by man for the use of the domestic herbivorous quadrupeds. In English, the term is commonly restricted to dried herbage, as hay and straw; but in other languages it is more comprehensive, and includes all the food of stock except what they gather for themselves in the field. The principal part of the food of all the domestic herbivora is furnished by grasses, almost all of which are eaten by them when fresh and green. Besides the supplies which they receive of all the kinds of corn cultivated for human food, they are also, to a considerable extent, dependent on the *straw* or dried herbage of the corn-plants for their winter provender; and that of many other grasses, cultivated on this account alone, is converted into *hay* for their use. Hay, being cut and rapidly dried whilst the plant is still full of sap, contains more nutritious matter than the ripened straw of the cereals. The most important fodder-grass is rye-grass, next to which must be ranked timothy-grass; but all the meadow-grasses and larger pasture-grasses also contribute to the supply of hay. Next to the grasses must be ranked different kinds of *leguminosæ*, affording food for stock in their seeds—as beans, peas, lentils, lupines, etc.—and in their herbage, on account of which many of them are cultivated, as clover, medick, melilot, vetch, tare, sainfoin, etc., of some of which there are numerous species. Some of these also often enter pretty largely into the composition of hay, being cut and dried with the grasses along with which they have been sown; which is the case also with some plants of other orders, as the ribwort plantain, etc. Some of the *cruciferæ* are cultivated to a considerable extent as forage-plants, cattle being fed on their green herbage, although they are not suitable for drying as fodder. In portions of the world, stock are not unfrequently fed on the leaves of trees, as in the Himalayas, where the leaves of different species of *aralia*, *grewia*, elm and oak, are chiefly employed for this purpose, and are collected, dried, and stacked for winter fodder. See *Forage*.

FOE.—An enemy in war; a national enemy; a hostile army; an adversary. Also written *Foeman* and *Fone*, but the latter is now obsolete.

FOGEY.—1. A term sometimes applied to an invalid soldier or sailor. 2. The common expression for extra pay for long service.

FOIL.—1. A thin bar of elastic steel, mounted as a rapier, but without a point, and additionally blunted at the end by the presence of a button covered with leather. See *Fencing*. 2. A general name for thin metal intermediate in thickness between *leaf-metal*, such as gold, silver, and copper leaf, and *sheet-metal*. There are two distinct kinds of foil in common use—the tin-foil used for silvering and for the conducting coatings of electrical apparatus; and the bright foils employed by the jewelers for backing real or artificial gems, and thereby increasing their luster or modifying their color.

FOILING-MACHINE.—A machine employed in the fabrication of cartridge-primers. The one used at Frankford Arsenal, and represented in the drawing,



Foiling-machine.

is a single-action press arranged to receive and move horizontally the plate of caps under a gang of punches and dies. The strip of foil is fed between these tools, and by them cut into disks. The punches press the disks through the dies into the caps, and the ends of the punches, being concave, press the edges of the disks around the charges against the bottoms of the caps, and at the same time the punch gives the charge a uniform conical shape, that its height may permit the insertion of the anvil far enough into the cap to prevent any premature explosion in this operation and that of inserting the completed primer in the pocket of the shell, while leaving no unnecessary space between the anvil and the apex of the charge. See *Cartridge-primer* and *Center-primed Metallic-case Cartridge*.

FOISSONNEMENT.—A term used in fortification to signify the increase in bulk of earth after its excavation. This increase varies from one eighth to one twelfth generally. For all ordinary sand it is one twentieth.

FOLDING-BOAT.—A boat having a jointed framework covered with canvas, used in campaigning and by travelers.

FOLLOW-BOARD.—A board beneath the pattern, in the foundry, and on which the pattern lies while the loam is being rammed. See *Bronze Guns*.

FOLLOWER-WEIGHT.—A weight employed in the *feed-drums* of certain machine-guns to force the cartridges downward towards the barrels when firing. See *Gatling Gun* and *Feed-drum*.

FOLLOW UP.—To pursue with an additional vigor some advantage which has already been gained.

FOOD.—Although very nearly sixty elementary substances are known to chemists, only a comparatively small number of these take part in the formation of man and other animals; and it is only this small number of constituents which are essential elements of our food. These elements are carbon, hydrogen, nitrogen, oxygen, phosphorus, sulphur, chlorine, sodium, potassium, calcium, magnesium, iron, and fluorine.

Carbon, hydrogen, nitrogen, and oxygen are supplied to the system by the albuminous group of alimentary principles, viz., albumen, fibrine, and caseine, which occur both in the animal and vegetable kingdoms, and the gluten contained in vegetables. Animal flesh, eggs, milk, corn, and many other vegetable products contain one or more of these principles. The gelatinous group also introduces the same elements into the system when such substances as preparations of isinglass, calves' feet, etc., are taken as food. Carbon, hydrogen, and oxygen are abundantly introduced into the system in the form of sugar, starch (which occurs in large quantity in the cereal grains, leguminous seeds, roots, tubers, etc., used as food), and organic acids (which, as citric, malic, tartaric acid, etc., occur in numerous vegetables employed as food). Carbon, with a little hydrogen and oxygen, occurs abundantly in the oleaginous group of alimentary principles, as, for instance, in all the fat, suet, butter, and oil that we eat; in the oily seeds, as nuts, walnuts, cocoa-nuts, etc.; and in fatty foods, as liver, brain, etc. Phosphorus is supplied to us by the flesh, blood, and bones used as food (the flesh of fishes is especially rich in phosphoric matter), and in the form of various phosphates it is a constituent of many of the vegetables used as food. The system derives its sulphur from the fibrine of flesh, the albumen of eggs, and the caseine of milk, from the vegetable fibrine of corn, etc., from the vegetable albumen of turnips, cauliflowers, asparagus, etc., and from the vegetable caseine of pease and beans. Most of the culinary vegetables contain it, especially the *cruciferæ*. Chlorine and sodium, in the form of chloride of sodium, are more or less abundantly contained in all varieties of animal food, and are taken separately as common salt. Potassium is a constituent of both animal and vegetable food; it occurs in considerable quantity in milk, and in the juice that permeates animal flesh; and most inland plants contain it. We derive the calcium of our system from flesh, bones, eggs, milk, etc. (all of which contain salts of lime); most vegetables also contain lime-salts; and another source of our calcium is common water, which usually contains both bicarbonate and sulphate of lime. Magnesium in small quantity is generally found in those foods that contain calcium. Iron is a constituent of the blood found in meat; and it occurs in smaller quantity in milk, in the yolk of egg, and in traces in most vegetable foods. Fluorine occurs in minute quantity in the bones and teeth. This small quantity is accounted for by the traces of fluorine found by Dr. George Wilson in milk, blood, etc.

These simple bodies are not, however, capable of being assimilated and converted into tissue; they must be previously combined, and this combination is primarily conducted by the vegetable kingdom. The number of combined elements varies: thus water contains only 2; sugar, starch, fat, and many organic acids contain 3; caseine contains 5; and fibrine and albumen contain 6.

It would be impossible, and it is quite unnecessary, to mention in this article the different animals and plants that are used as food by different nations. The subject is, however, an interesting one, and those who desire to study it may be referred to Moleschott's *Physiologie der Nahrungsmittel* (1850), and especially to Reich's *Nahrungs- und Genussmittelkunde* (1860-61), which is the most learned and elaborate work on the subject in any language. See *Dietary*.

FOOT.—1. The most common unit of lineal measure all over the world. It has been evidently taken originally from the length of the human foot, and as that varies in length, so does the measure; each country, and at one time each town, having a foot of its own. The three foot-measures that occur most frequently are the Paris foot, or *pied de roi*, the (German) Rhenish foot, and the English. Compared with the French *meter* (= 3.28090 feet English), they stand thus:

		Meters.			Inches.
English foot	=	0.30479	Paris foot	=	12.78912
Paris "	=	0.32484	Rhenish foot	=	12.35652
Rhenish "	=	0.31385			

In round numbers, 46 French feet = 49 English feet, 34 Rhenish or German feet = 35 English, and 57 French feet = 59 Rhenish. The Russian foot is equal to the English. Almost every German State has or had a different foot. The Rhenish foot is that used in Prussia. The longest foot occurring is the old Turin foot = 20 inches English. Many local feet are only about 10 inches. The foot has almost uniformly been divided into 12 inches; the inch into 12 lines, often into tenths. The Frence *pied usuel* is the third part of the meter.

2. A term often applied to foot soldiers. The infantry is usually designated as the *foot*, in distinction from the cavalry.

FOOT-ARTILLERY.—Artillery soldiers serving on foot. The name is also applied to heavy artillery.

FOOT BOARDS.—The transverse boards on the front of a limber, on which the cannoneers rest their feet when mounted.

FOOT-FIGHT.—A conflict by persons on foot; in opposition to a fight when mounted or on horseback.

FOOT-GUARDS.—The flower of the British infantry, and the garrison ordinarily of the metropolis, comprise three regiments, the Grenadier, Coldstream, and Scots Fusilier Guards, in all 7 battalions and 6307 officers and men. See *Guards*.

FOOT-LEVEL.—A form of level used by gunners in giving any proposed angle of elevation to a piece of ordnance.

FOOT-POUND.—The unit by which the *work done* by a force is estimated; thus (taking 1 lb. and 1 foot as the units of weight and distance), if 1 lb. be raised through 1 foot, the *work done* is equal to 1 foot-pound; if 10 lbs. be raised 9 feet, the *work done* is 90 foot-pounds; and generally, if W represent the *work done*, P the *weight in pounds*, and h the *height in feet*, then W (in foot pounds) = Ph.

FOOT-TON.—In England the power of modern ordnance is estimated by the energy of the shot in foot-tons, divided by the number of inches in the shot's circumference. The expression for the energy is

$E = \frac{WV^2}{2\pi r . g}$, in which W is the weight of the shot in tons, V is the velocity, $2\pi r$ the circumference of the shot in inches, and g the force of gravity. $\frac{WV^2}{g}$ is the living force of the shot, and is equal to twice the quantity of work it is capable of doing.

FORAGE.—1. To collect supplies both for man and stock, from an enemy by force, and from friends by impressment. In the latter case receipts are given and the claims are paid ultimately.

2. The hay, corn, fodder, oats, etc., required for the subsistence of the animals in an army. It is of two kinds, green and dry; the former consists of green grass, tares, vetches, etc.; the latter of oats, hay, and sometimes of corn, fodder, barley, etc., according to circumstances and the country in which the animals may be serving. In India the daily food given to horses consists of grain and grass. Generally 4 seers or 8 pounds per horse is given of the former during the warm season, and 5 seers throughout the cold weather and when on the march. Grass, about 30 pounds daily, is provided by grass-cutters, of whom there is usually one to every two animals. On the march, should it be difficult to obtain grass, a requisition is made on the Civil Authorities to collect it at any named place. The forage for bullocks in India consists of 6 pounds of grain and 14 pounds of chopped straw, called *bhoosa.* Camels feed on the leaves of the pepul-tree. Elephants are fed on wheaten cakes mixed with molasses, called in India *gour.* The daily ration is from 15 to 30 pounds according to the size of the animal. The green food consists of sugar-cane or green leaves of different trees. Where troops are together, in England, the provision of forage devolves on the Commissariat: Officers of the Staff, etc., who are entitled to horses, but whose duties are at stations where bodies of horse are not collected, receive a money allowance, in lieu of forage in kind, varying according to the place and price of provender, but usually about 1*s.* 10*d.* to 2*s.* per horse per day. When a soldier is *en route* away from his regiment, the innkeeper with whom he stops is bound, under the Mutiny Act, to provide his horse with the specified ration of forage—viz., 10 pounds oats, 12 pounds hay, and 8 pounds straw, for the payment of 1*s.* 9*d.* a day, which must also include stabling. The daily ration in the United States army is for each horse 14 pounds hay and 12 pounds oats, barley, or corn. For a mule the same amount of hay with 9 pounds grain. Leaves of Indian corn are used in default of hay. The consumption of forage during active army operations is enormous, and the weight is four and a half times as much as that of all other subsistence supplies. During the War of the Rebellion there were issued from the depot of Washington 4,500,000 bushels of corn, 29,000,000 bushels of oats, and 490,000 tons of hay. Partial reports of the Quartermaster General show issnes of forage during the war as follows:

22,816,271 bushels of corn, costing	$29,879,314
78,663,799 bushels of oats, costing	76,362,026
1,518,621 tons of hay, costing	48,595,872
Total	$154,837,212

The weight of these supplies in pounds was—

Corn	1,277,711,176
Oats	2,517,241,568
Hay	3,037,242,000

—making a total of 6,832,194,744 pounds: numbers interesting as showing the magnitude of the operations necessary to provide and distribute these few items of the expenses of war.

The endurance and capabilities of the stock in the field will depend upon the proper supply of nutritious forage, and it is incumbent upon the soldier to instruct himself as to the properties and chemical constituencies of the different articles of forage.

Oats contain about three fourths their weight of nutritious matter. When good they should be dry, sweet, heavy, and rattle like shot. They are most nutritious when about one year old. New oats are difficult to digest, and often occasion colic and staggers. All such, or those that are wet and musty, should be kiln-dried before feeding. Oats possess an invigorating principle not found in any other grain. Oat-meal, in the form of gruel, constitutes one of the most satisfactory articles of food for the sick and tired horse. Hay should be one year old, if procurable, when fed. New hay acts as a purgative. Old hay becomes dry, tasteless, innutritive, and often mow-burnt, in which condition it becomes really poisonous. Horses fed on such soon become languid, hide-bound, worthless, and often victims of diabetes. Hay must not be fed in too large quantities. Many diseases of the horse are the results of over-feeding with hay. Horses are prone to eat more than they should, hence it is necessary to add grain containing more nutriment in a smaller compass. Barley contains about nine tenths its weight of nutritious matter, but is not so good as oats as an article of food. Animals fed upon it are subject to mange, surfeit, and inflammatory complaints. Barley-straw induces diseases of the skin. Wheat contains more nutritious matter than barley and more gluten than any other grain. It should be fed in small quantities, or colic and fomentation will result. It is difficult of digestion, and the horse fed on it should have but little hay and water soon afterwards. Under certain conditions the addition of other articles to the forage ration is very beneficial. Peas and beans, in small quantities and about one year old, are excellent articles of food for horses. They should be well crushed before feeding, and generally fed with hay. If fed alone they might produce the meagrims or staggers. Carrots when sliced and mixed with grain make a splendid provender for the horse, and are found to be very beneficial in all breathing and skin disorders, coughs, and broken wind. They should be fed in small quantities, as they are slightly laxative and diuretic at first. Potatoes possess great virtue as an article of horse-food. If they are slightly steamed before feeding, horses will prefer them to oats. If they are mixed with other provender, there is a great saving in expense and an increased capability for work. One acre of potatoes is equivalent to four acres of hay.

FORAGE-CAP.—The small, low cap worn by officers and enlisted men when not in full dress. In the United States army the following patterns are worn: *For General Officers.*—Of dark blue cloth, chasseur pattern, with black velvet band and badge in front; cap-cord of gold lace. *For all other Commissioned Officers.*—Of dark blue cloth, chasseur pattern, with badge of corps or regiment in front, and top of badge

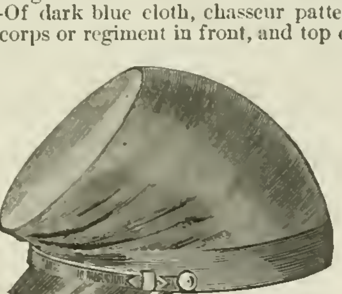


Fig. 1.

to be even with top of cap; cap-cord of gold lace. *For all Enlisted Men.*—Of plain blue cloth, same pattern as for officers, with badge of corps or letter of company of yellow metal, worn in front as for officers. The following are the authorized forage-cap badges for officers and men: *For General Officers.*—A gold-embroidered wreath on dark blue cloth ground, encircling the letters U. S. in silver, old English characters. *For Officers of the Adjutant General's Department.*—A solid shield of silver bearing thirteen stars, according to pattern in the Adjutant General's Office. *For Officers of the Engineers.*—A gold-embroidered wreath of laurel and palm encircling a silver turreted castle on dark blue cloth ground. *For Officers of Ordnance.*—A gold-embroidered shell and flame on a dark blue cloth ground. *For Officers of the Signal Corps.*—According to the pattern deposited in the office of the Chief Signal Officer.—*For Officers of the other Staff Corps.*—The same as prescribed for General Officers. *For Officers of Cavalry.*—Two gold-embroidered sabers, crossed, edges upward, on dark blue cloth ground, with the number of the regiment in silver in the upper angle. *For Officers of Artillery.*—Two gold-embroidered cannons, crossed, on dark blue cloth ground, with the number of the regiment in silver at the intersection of the cross-cannon. *For Officers of Infantry.*—Two gold-embroidered rifles without bayonets, barrels upward, on dark blue cloth ground, with the number of the regiment in silver in the upper angle. *For Light Artillery and Cavalry Soldiers.*—

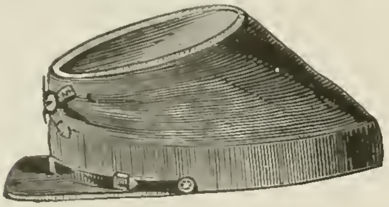


Fig. 2.

The numbers of their regiments in the upper, and the letters of their companies in the lower, angles of the badges of their respective arms upon the forage-caps. *For Ordnance Sergeants and Soldiers.*—The "shell and flame" on the dress and forage caps. *For Hospital Stewards.*—The letters "U. S." in white metal, inclosed by wreath, on dress and forage caps. *For Commissary Sergeants.*—Crescent in white metal, the points in a vertical line, on the dress and forage caps. *For Engineers.*—The castle, with letter of company above it, on dress and forage caps. *For Artillery.*—The crossed cannons, with number of the regiment in upper, and letter of company in lower, angles, on dress and forage caps. *For Infantry.*—The crossed rifles, with the numbers of regiment and the letters of company placed as for artillery, upon dress and forage caps. *For Field and Band Musicians.*—Bugle, with numbers of regiment in the center, and the letters of the company above the bugle. See Figs. 1 and 2.

FORAGE-GUARD.—A detachment sent out to secure foragers. They are posted at all places where either the enemy's party may come to disturb the foragers, or where they may be spread too near the enemy, so as to be in danger of being taken. This guard consists both of horse and foot, who must remain on their posts till the foragers are all off the ground.

FORAGE-MASTER.—A person in charge of the forage; his duties being to provide the necessary forage and its means of transportation. The Quartermaster General is authorized to employ from time to time as many Forage-masters as he may deem necessary for the service, not exceeding twenty. See *Wagon-master.*

FORAGING.—The collection of forage or other supplies systematically in towns or villages, or going with an escort to cut nourishment for horses in the fields. Such operations frequently lead to engagements with the enemy. Foraging-parties are furnished with reaping-hooks and cords. The men promptly dismount, make bundles with which they load their horses, and are prepared for anything that may follow. The word *foraging* is sometimes inaccurately used for marauding. When foraging is effected in villages, it is best not to take the party into the village, but to send for the chief persons and stipulate with them that the inhabitants shall bring the required forage and other stores out to the troops. If the inhabitants do not promptly comply with this moderate command, it is necessary to take the troops into the village. In this event all possible means must be taken to prevent disorder, as for instance: 1. A certain number of houses are assigned to each company, so that the Commander of the detachment may hold each company responsible for the disorders committed within its limits. 2. Guards are posted and patrols sent out, who arrest any foragers guilty of disorder. 3. If the form of the village permits, a part of the detachment remains at the center to pack the horses and load the wagons as fast as the other men bring the forage from the houses. In places where an attack may be expected, the foraging is conducted as follows: Either fatigue-parties are sent with wagons, or parties of cavalry with their own horses; in both cases a special escort is added for the protection of the foragers. In all cases the strength of the escort depends upon the degree of danger, the space over which the foraging is to extend, and the distance from the enemy. During the march of foragers to and from the foraging-ground, if they consist of a fatigue-party with wagons, an escort is added, which acts in conformity with the rules for escorting convoys. If the foragers consist only of cavalry with their own horses, then on the outward march they move in one body, observing the precautions prescribed for movements near the enemy; on the return-march, if the horses of the foragers are packed and led, the detachment acting as escort should not pack more than forty pounds on their horses, so that the load may not prevent them from acting against the enemy. Sometimes the escort, or a part of it, may be sent out early to the foraging-ground to take measures for the security of the foragers before they arrive. For the safety of the foragers when at their work, the escort is divided into two or three parts, according to circumstances; one part places a chain of outposts and sends out patrols to guard the whole ground; another furnishes the supports of the outposts, and if there are infantry or mounted rifles with it they occupy the points which cover the approaches; the third part is placed in reserve near the center of the ground, that it may easily reach any point attacked. If the enemy attacks while the foraging is going on, the escort should go to meet him or defend itself in position, endeavoring to stop him until the foragers have finished their work and are drawn out on the road for their return-march; then the escort commences its retreat, acting as a rear-guard, and endeavoring to keep the enemy as far from the foragers as possible. If it is impossible to hold the enemy in check long enough to finish the work, they should at least send forward and protect all the foragers who have packed their horses or loaded their wagons; the rest join the escort. If there is a probability of driving off the enemy by uniting all the foragers to the escort, it is best to abandon the forage already packed, and to begin foraging anew after having repulsed the enemy. It is permitted to abandon the forage entirely only in extreme urgency, when there is absolutely no other way of saving the foragers. If the enemy is repulsed, we must not be induced to pursue him except far enough to prevent a renewal of the attack, but must endeavor to complete the foraging. The foraging must not be extended over any ground not guarded by the escort. If the escort is too weak to cover the whole space designated for foraging, the ground is divided into parts, and the foraging effected in the different portions successively. If the foraging-ground is at a considerable distance from the camp, it will be a proper precaution to post a special detachment in support half way. Foraging in places occupied by the enemy is undertaken only upon the entire exhaustion of the ground occupied by our own troops. Such foraging is covered by offensive operations, so that, having driven in the enemy's advanced troops or other parties, we may rapidly seize all the supplies to be found in the vicinity. This is called *forced foraging.* The strength and composition of a detachment for forced foraging must be such that it can overwhelm the enemy's troops, and remain long enough in position to enable the accompanying detachment of foragers to complete their work and retreat out of danger. The main conditions of success in such an enterprise are suddenness, rapidity, and determination in the attack, promptness in the work of the foragers, and tenacity in holding the position taken from the enemy as long as necessary. Success will be greatly facilitated by partial attacks made upon different points of the enemy's position while the foraging is going on. Attacks upon foragers should be sudden and rapid, in order, by not giving the escort time to defend the points attacked, to produce confusion among the foragers and thus prevent them from working. The approach of the attacking party should be concealed, rapid, and compact; that is, it should not send out parties to any great distance in front or on the flanks, and, as a general rule, should not divide its force prematurely, but only the moment before the attack. The force of a detachment sent to attack foragers depends chiefly upon the object of the attack—that is, whether it is designed to capture the foragers, or only to prevent them from foraging by alarming them, or to prevent them from carrying off forage already packed. It is in all cases advantageous to begin with several simultaneous false attacks by small parties, to perplex the enemy and oblige him to divide the escort; then to direct the main party of the detachment upon the principal point of the enemy's arrangements, overthrow his weakened escort, and penetrate to the road of retreat, so as either to cut off and destroy a part of the escort and foragers, or to force them to abandon their work and fly, by threatening to cut them off. If from the disproportion of force it is impossible to prevent the foraging entirely, the attacking party confines itself to delaying the work; its operations, therefore, should consist in partial attacks upon several points, in order to alarm and disperse the foragers by breaking through the outposts at several points. Upon meeting any considerable force of the enemy these attacking parties should at once retreat, and renew the attack in a different place. In such operations a portion of the attacking detachment should be kept together and held in reserve, as a support and rallying point for the small parties. If they do not succeed in preventing the foraging, they may try to attack the foragers on the return-march; observing in this case the rules laid down for attacks upon convoys. See *Convoy*.

FORCAT.—A rest for the musket, used in very ancient times. It is now obsolete.

FORCE.—Until we know what matter is, if there be matter, in the ordinary sense of the word, we cannot hope to have any idea of the absolute nature of force. Any speculations on the subject could only lead us into a train of hypotheses entirely metaphysical, since utterly beyond the present powers of experimental science. If we content ourselves with a definition of force based on experience, such a definition will say nothing of its nature, but will confine itself to the effects which are said to be due to force, and in the present state of our knowledge it is almost preposterous to aim at more. Our first ideas of force are evidently derived from the exertion required to roll, or lift, bend, or compress, etc., some mass of matter; and it is easy to see that in all such cases where muscular contraction is employed, matter is moved, or tends to move. Force, then, we may say generally, is *any cause which produces, or tends to produce, a change in a body's state of rest or motion.* The amount or magnitude of a force may be measured in one of two ways: 1. By the pressure it can produce or the weight it can support; 2. By the amount of motion it can produce in a given time. These are called respectively the statical and dynamical measures of force. The latter is, as it stands, somewhat ambiguous. What shall we take as the quantity of motion produced? Does it depend merely on the velocity produced, or does it take account of the amount of matter to which that velocity is given? Again, is it proportional to the velocity itself, or to its square? This last question was very fiercely discussed between Leibnitz, Huyghens, Euler Maclaurin, the Bernouillis, etc.; Leibnitz being, as usual with him in physical questions, on the wrong side. Newton, to whom we owe the third law of motion, had long before given the true measure of a force in terms of the motion produced. This law is an experimental result—that when pressure produces motion, the *momentum* produced is proportional to the pressure, and can be made (numerically) equal to it by employing proper units. Hence, momentum is the true dynamical measure of force, which, therefore, is proportional to the *first* power only of the velocity produced. What is properly measured in terms of the *square* of the velocity we shall presently see.

It is obvious that in order to produce any effect at all, or to do WORK, as it is technically called, a force must produce *motion*, i.e., must move its point of application. A weight laid on a table produces no effect whatever unless the table yields to the pressure; i.e., unless that weight descends, be it ever so little. We do no work, however much we may fatigue ourselves, if we try to lift a ton from the floor; if it be a hundred-weight only, we may lift it a few feet, and then we shall have done work—and it is evident that the latter may be measured as so many pounds raised so many feet—introducing a novel unit, the *foot-pound*, which is of great importance, as we shall shortly see, in modern physics. This is evidently, however, a statical measure of work, since no account is taken of velocity. Have we then for work, as we had for force, a *dynamical* measure? Let us take a simple case, where the mathematical investigation is comparatively very easy, and we shall find we have. We know that if a particle be moving along a line (straight or not) and the distance moved (in the time t) along the line from the point where its motion commenced be called s, its velocity is $v = \frac{ds}{dt}$. Also we know that the force acting on it (in the direction of its motion) is to be measured by the increase of momentum in a given time—this gives (just as the last equation was obtained) $F = m\frac{dv}{dt}$. From these two equations, we have, immediately, $mvdv = Fds$, or, as the rudiments of the differential calculus give at once, $\frac{mv^2}{2} = \int_0^s Fds = F.s$ if the force be uniform. The quantity on the right-hand side is the sum of the products of each value of F by the corresponding space ds through which the particle moved under its action. It is therefore the whole work done by the force. On the left hand we find half the product of the mass, and the square of the velocity it has acquired; in other words, the vis-viva. Hence, in this case, the vis-viva acquired *equals* the amount of work expended by the force.

It appears from a general demonstration (founded on the experimental laws of motion, and therefore true, if they are), but which is not suited to the present work, that if, in any system of bodies, each be made up of particles or atoms, and if the forces these mutually exert be in the line joining each two, and depend merely on the distance between them, then we can express the required proposition in the following form: *Any change of vis-viva in the system corresponds to an equal amount of work gained or lost by the attractions of the particles on each other.* What is spent, then, in work is stored up in vis-viva; and conversely, the system, by losing some of its vis-viva, will recover so much work-producing power. If we call the former, as is now generally done, *kinetic*, and the latter *potential*, *energy*, we may express the above by saying, that in any system of bodies where the before-mentioned restrictions are complied with, *the sum of the kinetic and potential energies cannot be altered by the mutual action of the bodies.* The most simple and evident illustrations of this proposition are to be found in the case of the force known as gravitation. The potential energy of a mass on the earth's surface is zero, because, not being able to descend, it has, in common language, no work-producing power. If it be raised above the surface, and then dropped, it is easy to see that the work expended in raising it will be exactly recovered as vis-viva after its fall. For a mass falling through a space h to the earth acquires a velocity v, such that $v^2 = 2gh$; or if m be the mass, $\frac{mv^2}{2} = mg.h$. The left-hand side gives the vis-viva acquired by the fall; the right is the product of the weight (mg) and the height fallen through —or is the work required to elevate the mass to its original altitude. Hence we may calculate the amount of work which can be obtained from a *head* of water in driving water-wheels, etc., remembering, however, that there is always a *loss* (as it is usually called) due to friction, etc., in the machinery. That there is a loss in useful power is true, but we shall find presently that in energy there is none, as indeed our general result has already shown. *Where* the apparently lost energy goes is another question. Another good example of potential energy is that of the weights in an ordinary clock. It is the gradual conversion of potential into kinetic energy in the driving weight which maintains the motion of the clock, in spite of friction, resistance of the air, etc.; and we have in the kinetic energy of sound (which depends on vibrations in the air) a considerable portion of the expended potential energy of the striking weight. A coiled watch-spring, a drawn bow, the charged receiver of an air-gun, are good examples of stores of potential energy which can be directly used for mechanical purposes. The chemical arrangement of the different components of gunpowder or gun-cotton is such as corresponds to enormous potential energy, which a single spark converts into the equivalent active amount. But here *heat* has a considerable share in the effects produced; it may then be as well, before proceeding farther, to consider how we can take account of it and other (so-called) physical forces as forms of energy.

The physical forces that require to be carefully noticed in this work may be thus classified: 1. Gravitation; 2. Molecular Forces, including Cohesion, Capillarity, Elasticity, and Chemical Affinity; 3. Heat and Light; 4. Electricity, including Magnetism. Of these, classes 1 and 2, and some forms of class 3, are more immediately connected with *matter* than the others—that is to say, that the remainder almost necessitate the hypothesis of the existence of some medium unlike ordinary matter, or, in popular language, an *imponderable*. The almost universal opinion of physicists, however, seems to be that even the former must be accounted for in some such way. Of what that medium might consist we cannot, of course, hazard even a conjecture; but if it be composed of separate atoms—i.e., not continuous—it is evident that a second medium will be required to help the particles of the first to act on each other (for without this the first medium would be merely obstructive), and so on. This must stop somewhere; why not, then, at the first? But in the present state of our understanding of mechanics a continuous medium is barely conceivable, and its motions, etc., present considerable difficulties to even plausible mathematical treatment. If we take the view opposed to Newton's, as Mosotti and others have done (their ideas are considered farther on), we can, in a very artificial manner, however, account for gravitation and molecular action; but, as before said, the foundations of this attempt at explanation are hardly tenable. Just as sound depends on the elasticity of the air and vibrations thereby maintained and propagated, light and radiant heat, which are certainly identical, most probably consist in the vibrations of some very elastic fluid. This has been provisionally named ether. If it be continuous, it may help us to account for the first two categories of force also, as we have already seen; if not so, as is more likely, fresh difficulties arise. Light and heat, however, undoubtedly depend on motion, and correspond, therefore, to so much of vis-viva or actual energy. Even heat in a liquid or solid body must correspond to some vis-viva in the material particles, since a hot body can give out both light and heat, and a body may be heated by luminous or calorific rays which are vibratory, as we have seen. Class 4 contains perhaps the most puzzling of all these forces. That there is something in common in all the forms of electricity, and that magnetism is nearly related to them, is certain; it is probable, also, that frictional electricity, when statical, consists in something analogous to a coiled spring, or is one form of potential energy—the others being forms of kinetic energy. Some have supposed magnetism to be also a form of potential energy, but Ampère's discoveries have materially lessened the probability of the truth of this hypothesis. We shall consider this again.

These forces can be transformed one into another. Take the potential energy of gravitation to commence with. We can employ it to drive a water-wheel. This turns a shaft, to which, if a tight brake be applied, heat will be produced by friction, and light also, if a rough wheel on the shaft be made to rotate against a piece of flint or pyrites; or electricity may be produced by employing the moving power to turn an ordinary electrical machine, or a magneto-electric one; and from the electricity so produced electrical charges and currents may be derived; from them heat and light again. Or the currents may be employed to magnetize a needle or a piece of soft iron, or to produce chemical decomposition. Again, heat may be employed by means of a steam-engine as a substitute for the water-power or potential energy of gravitation, and the above effects be produced. It may also be employed in raising weights, and therefore in producing the potential energy in question; or it may be employed to produce thermo-electric currents, and thence all the ordinary effects of electricity, including the motion of a magnetic needle. Light may be employed to produce chemical combination or decomposition, as we see in photography; it may also by the same means be made to produce electric currents, and consequent *motion* of a needle. It is not yet proved that light can produce magnetism *directly*, though there can be little doubt that, if properly applied, it is capable of doing so. Chemical action in a voltaic battery can be made to produce motion, heat, light, electricity, electrical charges and magnetism, and to overcome other chemical affinity. Capillary action has been employed to produce electricity and mechanical effects, etc., but we need not go through the whole category. In these experimental results, then, consist what is called the correlation of the physical forces—i.e., the transmutability of one of the latter into another or others. The idea is old, but the proofs of its truth have only become numerous within the last half-century. Grove has published an excellent treatise with the above title; to this we refer the curious reader for further detail on this interesting subject.

A far more important principle, being, in fact, the *precise* statement of the preceding—which is somewhat vague—is that of the conservation of energy. It is simply the extension (to all physics) of the principle which we have given in full, and proved in a particular case, at the beginning of this article—i.e., that the sum of the potential and kinetic energies of any set of moving bodies cannot be altered by their mutual action. Let us now suppose heat, light, etc., to consist in the energy of vibratory movements of particles, and in their relative states of distortion, etc., and make the supposition that these particles act on each other—no matter by what means—in the line joining each two, and with forces which depend on their distance, and we have at once the theorem that the sum of the potential and kinetic energies is a quantity unalterable in any system, save by external influences. Hence, when mechanical power is said to be lost, as it is by the unavoidable friction in machinery, etc., it is really only changed to a new form of energy—in general, heat. Thus, when a savage lights his fire, he expends animal energy in rubbing two pieces of dry wood together. If these pieces of wood were not in contact, no force would be required to move them past each other—more and more is required as they are more strongly pressed together. The equivalent of the energy so expended is found in the heat produced. Davy showed that two pieces of ice might be melted by rubbing them together. A skillful smith can heat a mass of iron to redness by mere hammering. Here the energy actually employed is partly given out in the shape of heat, and partly stored up in the iron as potential energy due to the compression of the mass, or the forcible approximation of its particles. Amongst the earliest, and certainly the *best* experiments on this subject, are those of Joule. He determined the relation between the units of heat and potential energy of gravitation by various methods, which gave very nearly coincident results. One of these we may mention. A paddle-wheel is so fixed as to revolve in a closed vessel full of water. The wheel is driven by the descent of a known weight through a measured space, and precautions are taken against losses of energy of all kinds. The water agitated by the paddle-wheel comes soon to rest, as we know; but this is due to friction between its particles; and the final result is the heating of the water The quantity of water, and also the number of degrees by which its temperature is raised, being measured, a simple proportion enables us to find how many foot-pounds of mechanical energy correspond to the raising by one degree the temperature of a pound of water. The result is that the heating a pound of water one degree Fahrenheit is effected by 772 foot-pounds—and this number is called Joule's equivalent. In other words, if a pound of water fall to the ground through 772 feet, and be then suddenly arrested, its temperature will be raised one degree; and, conversely, the heat that would raise the temperature of a pound of water one degree would, if applied by a steam-engine or otherwise, raise 772 pounds one foot high. Now we know the amount of heat which is produced by the burning (in air) of any material whose composition is known. It follows, then, that from the mere quantity and composition of a substance we can tell the amount of mechanical work due to its combustion; that is, supposing it all to be effective.

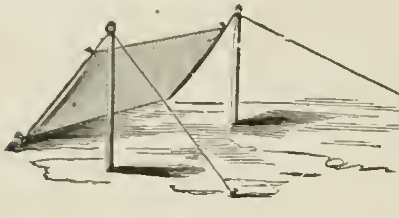
An immediate consequence of the truth of the conservation of energy is the impossibility of what is usually understood by the perpetual motion; for it is to be carefully remembered that perpetual motion, in the literal sense of the words, is not only possible, but very general. If there were no such thing as friction, or if we had a perfectly smooth body, in the form of a teetotum, for example, it would spin forever in vacuo with undiminished speed. The earth in its axial rotation affords a good example. Were it a perfect sphere, and of uniform material, the other masses of the system could produce no effect whatever on its rotation, and the latter would remain forever unchanged. And even, as we have already seen, when one form of kinetic energy, as electricity, or ordinary vis-viva, is lost, we find it reappearing in other forms of kinetic energy, such as heat and light. But this is not the technical acceptation of the term, the perpetual motion; it is popularly understood to mean a source of motion which will not only preserve its own vis-viva unchanged, but also *do work*. This is, of course, incompatible with the conservation of energy, for wherever work is done, equivalent energy in some form or other is consumed. The ordinary attempts to obtain "the perpetual motion" which are still being made in thousands by visionaries are simply absurd, based as they are for the most part on ignorant applications of mechanics. There is absolute impossibility here; and a "perpetual motionist" of the common herd is far more infatuated than a "squarer of the circle;" for the latter's problem *may* be solved, although certainly not by the means usually employed, or in the form usually sought for. There are, in mechanics, several other quantities which retain a fixed value under certain circumstances. We may briefly consider a few of them.

Conservation of Areas.—We have seen in the article CENTRAL FORCES that if a particle move about a center of force, its motion is confined to a plane, and its radius vector traces out equal areas in equal times. Similar theorems hold in any system of particles acted on only by their mutual attractions. If in such a system we suppose the positions of the respective particles to be continually projected (orthogonally) on *any* fixed plane, and radii vectores to be drawn from *any* point in that plane to the projections—*the sum of the areas swept out by all those radii vectores will be equal in equal times.* Also, this being true of all planes, there is one for which this sum is a maximum, and *this plane is fixed in space.* It is thence called the invariable plane of the system. Similar propositions hold for a system of bodies each of finite size, their several axial rotations being taken into account; hence what is called the invariable plane of the solar system.

Conservation of Momentum.—When two masses attract or impinge, the forces they exert on each other are evidently equal and opposite. Now, the measure of a force is the momentum it produces; hence equal and opposite momenta, in addition to their original quantities, will be communicated to the masses, and therefore the sum of the momenta of the two, resolved in any direction, will be unaltered; hence *the sum of the momenta of any number of bodies will be unaltered by mutual actions either of the nature of attraction or impact.*

Conservation of the Motion of the Center of Gravity.—Again, in such a system, the momentum of the whole collected at its center of inertia, resolved in any assigned direction, is the sum of the momenta of the separate bodies in that direction; hence *the center of inertia of a system subject to none but the mutual actions of its components either remains at rest or moves uniformly in a straight line.* See *Center of Gravity, Central Forces, Couples, Energy, Falling Bodies, Gravity, Mechanical Powers, Motion, Parallelogram of Forces, Velocity, Virtual Velocities*, and *Work*.

FORCED MARCHES.—Whether forced marches are offensive or defensive, the important considerations are to travel rapidly without encumbrance and to have at hand all things necessary for the comfort and safety of the command. The matter of proper equipment for the forced march is frequently a difficult one, when the element time is an uncertain factor, and the character of the country to be traveled over is unknown. Assuming that, in case of necessity, the country will afford the necessary supplies, the question of most proper equipment may be easily disposed of in particular cases. Whether the troops are mounted or not, the equipment should be selected so as to avoid all strains and unequal pressures; and, with a constant view to comfort and convenience, the useful points should be most numerous and the weight *in toto* a minimum. Of course, the time will never come when regular troops will scout or campaign without tents; but there is no doubt as to the bivouac, a temporary makeshift, being far preferable to tenting in a dangerous or rugged mountainous country. Bivouacking is not only healthier, in consequence of the soldier inhaling purer air, but he is enabled to better see and hear, and does not indicate to sneaking hostiles the exact spot where he is lying and enable them to move accordingly. A mound of sand or earth, covered by a cloth or blanket, will make an excellent pillow; whilst a blanket judiciously pitched over a little turned-up earth or an accumulation of twigs, leaves, or grass, serving as a comfortable bed, will afford a shelter surprisingly complete so far as protection from cold winds or drifting rains is concerned. This plan of flying camps could be very advantageously carried out by transporting extra *combination-blankets*, so made as to admit of being worn as aprons when moving through wet bushes or during rainy weather, and to be packed, when not in use, singly or in great numbers (as horse-blankets) upon any loose stock that may accompany the command. The blankets will prove invaluable for many purposes after the march is completed, even if it is not desirable to adjust them as shelters. The Indians of the Northwest, when traveling rapidly, invariably



transport extra blankets on the led-horses, and make such uses of them as the nature of the weather necessitates. When not engaged in forced marches, and when not compelled to leave the means of transportation, the men should bear only their rifles, ammunition, intrenching-tools, and at times canteens. The haversack and contents are useless and burdensome. It is not needed during an ordinary march, and is certainly in the way about the time of an engagement. A few pieces of hard bread placed in the hip-pocket of the soldier do not incommode him and are always attainable, whereas the haversack is often lost, and oftener abandoned before the soldier has had an opportunity to attend to his hunger. See *Farrow Combination-tent* and *Route-marches.*

FORCES.—An army of all branches—artillery, cavalry, and infantry. The word is sometimes used in the singular number, but with the same signification. The *effective forces* comprise all the efficient parts of an army that may be brought into action, with their necessary appendages, such as Hospital Staff, Wagon-train, etc. The Navy of a country must be looked upon as part of the effective force of the country, to which is added the Marines.

FORCING.—As applied to a projectile, forcing is the operation by which it is made to take hold of the grooves of a rifled barrel and follow them in its passage through the bore. It may be accomplished in various ways, most of which depend upon the soft and yielding nature of lead, the material of which small arm projectiles are made, viz.: 1. By the action of the ramrod. 2. By the action of the powder. 3. By the action of ramrod and powder combined. 4. By the form of the bore or projectile, as in breech-loading arms, etc.

When rifles were first made, forcing was effected by making the projectile a little larger than the bore, and driving it down with a mallet applied to the point of the ramrod; although this caused the lead to fill the grooves completely, converting the projectile into a screw, whereof the barrel was the nut; the operation was slow and laborious, and the accuracy of the projectile was impaired by the consequent disfiguration. The form of the grooves then used is shown in Fig. 1. They were liable to be injured by the ramrod, and were difficult to clean.

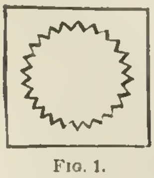


Fig. 1.

The foregoing plan was improved by making a projectile a little smaller than the bore, and wrapping it with a patch of cloth, greased, to diminish friction in loading. The thickness of the cloth was greater than the windage; this caused the patch to press upon the projectile with so much force as to compel it to follow the winding of the grooves without materially altering its shape. The patch is still used in sporting-rifles, and gives excellent results; but the loading is too slow and difficult for a military arm.

M. Delvigne, an officer of the French infantry, appears to have been the first person who overcame the difficulty of loading rifles, thereby removing the principal obstacle to their introduction into the military service. The plan proposed by him, in 1827, was to make the projectile small enough to enter the bore easily, and to attach it to a *sabot*, or block of wood (*a*) (as shown in Fig. 2), which, when in position, rested

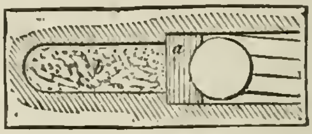


Fig. 2.

upon the shoulders of a cylindrical chamber (*b*) formed at the bottom of the bore to contain the powder. In this position the projectile was struck two or three times with the ramrod, which expanded the lead into the grooves of the barrel. To the bottom of the sabot was attached a piece of greased serge, which served to soften the residuum of the powder and facilitate the loading. By this plan the accuracy of the round projectile was increased, but its range was diminished.

In 1742 Robins pointed out the superiority of the oval or elongated form of projectile, and since this many attempts have been made to employ it in rifled arms, especially in this country; but it remained for M. Delvigne, followed by MM. Thouvenin and Minié, of the French service, to apply it successfully to the military service. The form of projectile proposed by these officers was composed of a cylinder and conoid. The cylinder served as the base of the projectile, and gave it stability in the bore of the piece; the conoidal surface, which formed the point, was well adapted to diminish the effect of the air, by increasing the penetrating power of the projectile. A single groove was formed around the cylinder, to contain a greased woolen thread, in place of the woolen patch of Delvigne. It was shown by the trials which followed that the presence of this groove improved the accuracy of the projectile—a fact which gave a new turn to the investigations, and led to the adoption of two additional grooves. The theory advanced in explanation of the action of these grooves was, that they oppose a resistance to the air which, acting on the rear portion of the projectile, tends to keep the point foremost in flight, thereby rendering the resistance of the air uniform, and at the same time a minimum. The correctness of this theory may be well questioned;

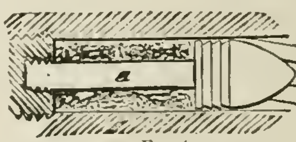


Fig. 3.

but that the grooves exert a beneficial effect, by diminishing adhesion to the surface of the bore, and by facilitating expansion, can scarcely admit of a doubt.

Colonel Thouvenin proposed to replace the chamber of Delvigne by a spindle of iron, screwed into the center of the breech-screw (see *a*, Fig. 3). This was found to be an excellent point of support for the base of the elongated bullet when forced by the blows of the ramrod. The expansion of the lead into the grooves secured the bullet in place, and protected the powder from moisture. Considerable difficulty, however, was experienced in cleaning the space around the spindle; and, like all plans of forcing by the ramrod, it is subject to variation, arising from the particular care and strength exercised by the soldier.

The method of forcing by form of projectile is illustrated in the Whitworth rifle. The form of the bore, as in the cannon, is a twisted hexagonal prism, making a complete turn in 20 inches. The projectile is made nearly of the exact form and size of the bore, and is about three diameters in length. To prevent disfiguration and stripping, which are very liable to occur in bullets of this length, fired with high velocities, the lead is hardened by alloying it with tin and manganese; and to obviate fouling a greased wad is placed between the powder and bullet. As might be expected from the length of the bullet, the amount of twist, and the extreme accuracy with which the bullet fits the bore, the results obtained with this arm are much superior to those obtained with service-arms.

It appears that the first attempt to force a projectile by the action of the powder was made by Mr. Greener, an English gunsmith, in 1836. The plan which he tried consisted in forming a cavity at the base of an oblong bullet, and partially inserting in it a conical pewter wedge, which was driven in by the force of the powder in such manner as to expand the outer part of the bullet into the grooves of the barrel. Some years after this Colonel Minié produced a projectile constructed on the same principle, but, instead of a solid wedge, he used a cup of sheet-iron, which was inserted into a conical cavity (as seen in Fig. 4), at the base of the bullet. The point of the ball was cut off to prevent disfiguration by the flat head of the ramrod. This projectile, when fired from a rifle of service-caliber, generally possessed great range and accuracy; but it had certain defects which prevented it from being extensively used in the military service, viz.: it was compound in its structure; the cup was sometimes forced in obliquely, producing unequal expansion; and, from the large size of the cavity, the top was occasionally blown off, leaving the cylindrical portion adhering to the sides of the bore.

Fig. 4.

Not long after the introduction of the Minié bullet it was discovered that, by giving a suitable size and shape to the cavity, the wedge could be dispensed with. The projectile thus obtained was simple in its structure, and gave better and more reliable results than the one from which it was derived. The particular form and mode of expanding bullets varies in most military services; in general terms, however, all modern small-arm projectiles are *cylindro-conoidal* in shape, and a majority of them are forced by the action of the powder. The effect of the powder may be direct, as in the case where it acts in the cavity of a bullet; or it may be indirect, as when it compresses the bullet lengthwise, or, as it is technically termed, "upsets" it. See *Small-arm Projectiles.*

FORD.—When a river or rivulet is crossed without the aid of either a bridge or ferry, it is said to be forded, and an established place for this crossing is called a ford. Thus we have Oxford, Stratford, Deptford, Hungerford, etc., towns built around ancient fords. To the military engineer and the traveler in wild countries the selection of the safest place for fording a river is a matter of some practical importance. In the first place, the *widest* part of the river should be chosen, as, wherever a certain quantity of water is flowing, the wider its bed—the rapidity of the flow being the same—the shallower it must be. At the bend of a river the line of shallow water does not run straight across, but extends from a promontory on one side to the nearest promontory on the other. The stream usually runs deep along hollow curves, and beneath steep perpendicular and overhanging banks, whilst it is always shoal in front of promontories, unless the promontory is formed by a jutting rock. For safe fording on foot the depth of water should not exceed 3 feet; on horseback, 4 feet; or a foot less for each if the current be very strong. The bottom of a ford should be firm and even; weeds, blocks of stone, etc., are serious obstacles, especially for cattle. When a caravan, a number of troops or of cattle, have to cross, a sandy bottom is very bad, for the sand is stirred up and carried away by the stream, and renders the ford impracticable for the hindmost. For a small party hard sand or gravel is the safest bottom. The inhabitants of a district generally know the safest fords, and their experience affords a better guide than the best rules that can be given. Fords are continually varying, either from the swelling of the river or the shifting of its bed or banks, and therefore it does not follow that the place set down by one traveler as a safe ford will continue so for the next that succeeds him.

The best ford seldom leads directly across a stream, but must be selected at a point where the width of the stream is greater than usual, with the point of egress some distance down stream, in order that those crossing may secure the advantage of the current. In certain cases, however, owing to the formation of the river-banks, it is necessary to ford obliquely up the stream. This is always attended with much labor and difficulty, and frequently in the struggle with the current the footings of men and animals are lost. In such cases it will accomplish much if mounted men are placed at suitable points, to urge forward with whips any animals that do not work properly. To insure reaching the proper point of egress, some of the animals will need frequent assistance by means of attached lariat-ropes. When the river is deep and rapid, in consequence of the body's buoyancy diminishing its power to resist the action of the current, it might be well to place a heavy rock in the arms before entering the ford. When the different arms cross a ford separately, the infantry should precede the cavalry and artillery; otherwise they would destroy the bottom and render the crossing for the infantry difficult or impossible. While fording, it is important to direct the eyes to some fixed point upon the shore and not look at the water, and particularly when the water-course is broad or the current rapid. See *Bridges.*

FORE CARRIAGE.—That portion of a wagon consisting of the frame (formed by the sweep-bar, the splinter-bar, and futchells), the axletree together with its connections, and the front wheels.

FOREIGN ARMIES.—Looking at the armies of Europe from every point of view, their strength, the rapidity with which they can be mobilized, and the means of feeding them, they may be classed as follows:

First class...	1. Germany.
	2. France.
	3. Russia.
	4. Austria.
Second class.	5. Italy.
	6. England.
Third class..	7. Belgium.
	8. Turkey.
Fourth class.	9. Sweden and Norway.
	10. Holland.
	11. Denmark.
	12. Spain.
	13. Portugal.
	14. Switzerland.
	15. Greece.

The four armies of the first class can place together in the field, in round numbers, a combatant force of 3,400,000 men and 8652 guns, whilst they can count twice that number of men on paper. The expense of these armies exceeds £67,000,000 per annum. Russia, Turkey, and Austria keep their troops at least cost, viz., from £25 to £29 a year per man; the maintenance of the British soldier is by far the dearest, as it amounts to close upon £100 per annum. In Germany the cost is £38 11*s.* per man. Of the above-named fifteen States of Europe, seven have introduced the compulsory service as the means of raising their armies—Germany, Russia, Austria, France, Italy, Denmark, and Switzerland. Seven are recruited by conscription, or conscription and enlistment, viz., Spain, Turkey, Sweden and Norway, Holland, Belgium, Portugal, and Greece. The British army alone is solely dependent on voluntary enlistment. In the following armies the age for joining the Colors is 20, viz., Austria, France, Russia, Spain, and Switzerland; 21 in Germany and Sweden; 19 in Belgium; 18 in Italy; and 22 in Denmark and Norway. In England men enlist between 18 and 25. The term of service in Austria, Germany, Italy, and Greece is 12 years; in Russia, 15; in France and Turkey, 20; in England, 12; in Denmark, 16; and in Switzerland, 10. The direct term of army service—that is to say, the term the recruit or the conscript has to remain in the active army before entering the Reserve (exceptions omitted)—is, in Austria, Denmark, France, Germany, and Italy, 3 years; in England, 6; in Sweden and Norway, 5; in Turkey and Russia, 4. The training of a recruit lasts in Austria 8 weeks; Germany and Italy require but 6; Russia deems 26 requisite; France finds 13 sufficient; England, 16; whereas Turkey considers 12 weeks necessary for the drill-education of her soldier. The active army in Austria is composed of the Line, Reserve, and eventually of the *Landwehr*, together with the Substitute Reserve. In Germany the active army is composed of the same parts. Russia forms hers of the Line, Reserve, and Militia, who have served but 4 years in that branch of the army. France has her Active Army and her Reserve, followed by the Territorial Army and the Reserve of the Territorial. As in the case of Russia, her Reserves as well as her Territorial Armies are but on paper, as sufficient time has not elapsed for the new system to mature. Italy has the Line and the *Mobile Milizia*. In Turkey the active army is followed by three reserves, the *Idatyal*, the *Rédif*, and the *Ilyade*, the latter being a kind of *Landsturm*. In the six principal armies of Europe the proportion of guns and cavalry on active service to the strength of infantry is as follows:

Austria has....	103 cavalry	and 4 guns		per 1000 men.
France	119 "	" 3 "		
Germany	117 "	" 3 "		
Russia (Europe).	178 "	" 4 "		
" (Asia) ..	910 "	" 3 "		
England.......	133 "	" 4 "		
Italy	57 "	" 3 "		

The Austrian infantry is armed with the Werndl rifle, the Bavarian with the Werder, and the remainder of the German infantry with the Mauser rifle. France is gradually providing her troops of the line with the modified Chassepot called the Gras rifle, from the name of the officer who has improved this weapon. Denmark, Norway and Sweden use the Remington rifle. Italy and Switzerland have adopted the Vetterli rifle, Russia the Berdan, and Spain the Remington. Belgium has found the Albini-Braende rifle superior to all, and England and Turkey the Martini-Henry. The American troops are armed with the Springfield rifle. Before closing this article on the small-arms of the several foreign armies, a statement of the guns used by the four largest Continental powers may be considered interesting. The field-batteries of the German army are armed with the 8.8-centimeter B.L.R. gun, firing a shrapnel of 17 lbs. weight; the horse-artillery with the 7.85-centimeter B.L.R. gun, firing a shrapnel weighing 12.2 lbs. These guns are made of cast-steel, with polygrooved rifling and wedge-break action. For siege purposes the Germans use the 12-centimeter (4.68-inch) bronze gun, firing a 29-lb. shell, and steel and bronze guns of 15-centimeter (6.85-inch) caliber, firing a 54-lb. shell. A 21-centimeter shell gun is soon to be added to this arm. The field-artillery of Austria is composed of 8-pdr. and 4-pdr. bronze rifled guns, having calibers of 3.9 inches and 3 inches, firing 14-lb. and 8-lb. shell respectively. Steel B.L.R. guns of the Prussian type are, however, being gradually introduced. The mountain-batteries are armed with 3-pdr. rifled bronze guns; and for siege and garrison purposes the guns in use are B.L.R. 15- and 21-centimeters and 8-inch bronze guns. The Russian field-artillery is now armed with both cast-steel and bronze B.L.R. guns, 4-pdrs. and 9-pdrs. of 3.3-inch and 4-inch calibers, firing 12-lb. and 24-lb. shell respectively. For siege and garrison artillery they use 12-pdr. and 24-pdr. guns, throwing 30-lb. and 63-lb. shells, and 8-inch bronze and steel guns. The mountain-gun is a 3-pdr. bronze rifled gun, and fires a 9-lb. projectile. The field-guns of France are the 14-pdr. steel and 10-pdr. bronze B.L.R., the former the production of Colonel Reffye, the latter made by Major Pothier, and a steel 7-pdr. B.L.R. gun of a new pattern.

FOREIGN AUXILIARIES.—In the early periods of English history, the Foreign Auxiliaries were by no means uncommon. Harold had a body of Danes in his army when he defeated the Norwegian King, and to their refusal to march against the kindred Normans he owed not the least among the complications which ultimately overwhelmed him. Passing to modern times, William III. had for some time a body of Dutch troops in his pay as King of England; throughout the eighteenth century, Hessian and Hanoverian regiments were constantly in the pay of the English Government for temporary purposes. Hessians fought for the English in the first American war; and the Landgrave of Hesse, who sold his troops at so much a head, received upwards of half a million for soldiers lost in the campaign. During the Irish Rebellion, again, in 1798, many Hessian troops were employed.

On the outbreak of the Continental War in 1793, it was determined to recruit the British army by the addition of a large body of foreigners; and accordingly, in 1794, an Act was passed for the embodiment of the "King's German Legion," consisting of 15,000 men. These troops, who were increased in the course of the war to at least double that number, distinguished themselves in various engagements, and formed some of the regiments on which the Generals could best rely. Corps of French *Emigrés*, as the York Rangers and others, were also organized. The whole of the Foreign Legions were disbanded in 1815, the officers being placed on half-pay.

During the Russian War, in 1854, the British Government again had recourse to the enlistment of foreigners; special provision being made, in the Act authorizing their employment, that the arms of the Legionaries were in no case to be used against British subjects, in the event of internal discord. The numbers to be raised were 10,000 Germans, 5000 Swiss, and 5000 Italians; the pay to be the same as to British troops, but temporary service to convey no claim to half-pay. About half the number of men were enrolled, and were said to have reached great efficiency, when the stoppage of hostilities arrested their progress, and caused them to be disbanded at a great cost for gratuities, etc.

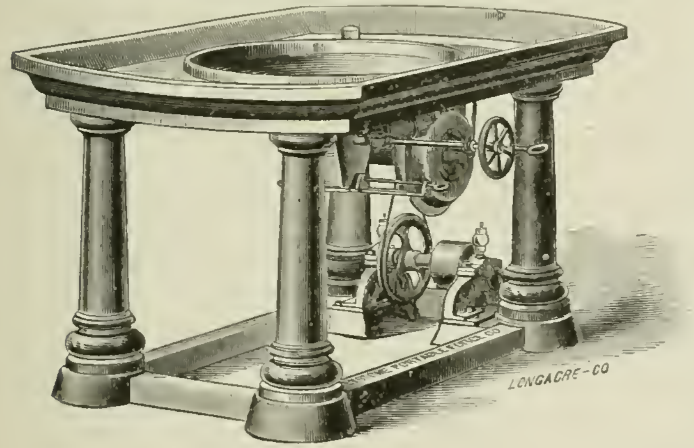
The Swiss Auxiliaries used to form a regular contingent in many of the armies of Europe, especially of France and of Italy. Over 1,000,000 served in France from the time of Louis XI. to that of Louis XIV. (1465–1715). See *Gardes Suisses*. Usually the Swiss served only on condition of being commanded by their own officers, and occasionally these officers obtained distinction and fame. But the privates returned home poor and often demoralized; and the Cantons which supplied most mercenaries suffered severely by their absence. After the French Revolution, the Cantons ceased publicly to hire out their subjects; and after 1830 most of the Cantons forbade foreign enlistment. In 1859 the Confederacy passed a severe law against recruitment for service abroad. There is still, however, a large contingent of Swiss as mercenaries in the Dutch East Indian Colonies. The Papal Swiss troops have shrunk to a body-guard of about 100 men.

FOREIGN-ENLISTMENT ACT.—In the law of England there was a statutory prohibition of enlistment in the service of a Foreign Prince. It provides that if any British subject shall agree to enter the service of any Foreign State, either as a soldier or a sailor, without the license of her Majesty, or an Order in Council or Royal Proclamation, or if any person within the British Dominions induces any other person to enlist in the service of a Foreign State, such a person shall be guilty of a misdemeanor. The Officers of the Customs, on information on oath, may detain any vessel having persons on board destined for unlicensed Foreign Service. Masters of vessels, knowingly having such persons on board, are punishable by fine or imprisonment, or both. Persons building any vessel for Foreign Service, without license, are guilty of a high misdemeanor, and the ship and stores are forfeited. Even to assist a Foreign State with warlike stores, without license, is a misdemeanor punishable with fine and imprisonment. These penalties are irrespective of any consequences that may follow to the individual for having committed any breach of international law.

FORELAND.—In fortification, the piece of ground between the wall of a place and the moat.

FORE-SIGHT.—1. A sight *forward* at the leveling-staff or through the sights of the circumferentor. 2. The muzzle-sight of a gun. See *Front Sight*.

FORGE.—The process of hammering red-hot iron or steel into any required shape is called forging, and the workshop in which the operation is performed, a forge. The principal tools of the common smith's forge are the forge-fire or hearth, with its bellows, the anvil, and the various hammers, swages, etc. For large work, an air-furnace, blown by steam-bellows, supplies the place of the simple hearth of the blacksmith, powerful cranes swing the work to its place on the anvil, and a steam-hammer strikes the blows that squeeze the red-hot mass into shape. Besides these, there are portable forges of various sizes and forms, used for military and other purposes. They usually consist of an iron frame, to which a bellows, worked by the foot, is attached; and above the bellows is an iron tray, with a hearth, etc., upon which the fire is made; and the anvil is either attached to this frame or has a separate stand.



Power-forge.

For the largest work to which hand-hammers are still applied, two gangs of from six to twelve hammermen are employed; they swing the large hammers with such wonderful precision and regularity that the instant one hammer is withdrawn another falls upon the same place. A foreman, with a wand, directs the hammering. The two gangs relieve each other alternately, on account of the great severity of the labor. Shovels, spades, mattocks, and many other tools and implements, are partly forged under the tilt-hammer.

The drawing shows a power-forge weighing 500 pounds, with a fire-pan 36×54 inches. It is well adapted for armory work, excelling in the arrangement of the gearing, strength of blast, and general working capacity. It is furnished with the Keystone fan-blower and revolving tuyere. This forge is well arranged for rapid work, and in all processes of forging it is of primary importance to obtain the greatest possible rapidity in the succession of the blows. There is a double reason for this: first, and simply, that the work is cooling, and the more slowly it is forged the more frequently it must be reheated; and secondly, that percussion generates actual heat, and when the blows are sufficiently heavy and rapid, the temperature of the work may be fully maintained out of the fire for some considerable length of time. The hammer used for tilting steel not only maintains the heat of the bar, but it raises it from a dull to a bright red heat. See *Cavalry Forge*.

FORGE-WAGON.—A wagon consisting of the body of an ammunition-wagon, carrying a movable frame for the bellows, hearth, anvil, etc., and the limber in which the necessary tools are conveyed.

FORLORN HOPE.—The body of men selected to attempt a breach or to lead in scaling the wall of a fortress. The name (which in the French, *enfants perdus*, is even more expressive) is given on account of the extreme danger to which the leaders of a storming-party are necessarily exposed. As, however, the honor of success is proportionate to the peril of the undertaking, there is ordinarily no lack of volunteers for this arduous service. The forlorn hope is called by the Germans *Die verlornen Posten*.

FORM.—In a general acceptation of the term, to assume or produce any shape or figure, extent or depth of line or column, by means of prescribed rules in military movements or dispositions. To *form on* is to advance forward, so as to connect with any given object of formation, and to lengthen the line.

FORMATION.—A term applied to that particular arrangement of the troops composing any unit when this latter is waiting for battle or is prepared to execute a movement. That portion of the formation upon the side towards the enemy is known as the *front;* the side opposite to the front is designated the *rear;* the lateral extremities are known as *flanks*. Any row of soldiers placed parallel to the front is known as a *file;* the number of ranks measures the depth of the formation.

FORMERS.—Round pieces of wood that are fitted to the diameter of the bore of a gun, round which the cartridge-paper, parchment, lead, or cotton is rolled before it is served. *Cartridge formers* are wooden shapes for cutting out the form and size of cannon cartridge-bags; their size and shape depend on the nature of the cartridge to be made. *Port-fire-formers* are used for making port-fire cases. They are made of wood, of a diameter slightly larger than the port-fire setting-drift. *Signal-rocket-formers* are used for forming the cases of signal-rockets. They have a movable piece from two to three diameters in length, which is termed the nipple, the smaller end of which fits into a hole made in the *former*, and when slightly drawn out keeps the neck of the case open while the choke is being formed and secured. *Wad-formers* are flat circular pieces of wood, hollowed out and grooved. They are employed for making up grummet-wads for guns.

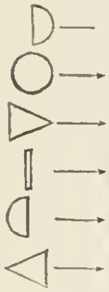
FORM OF PROJECTILE.—When a body moves through the air the gaseous particles in front are crowded upon each other until they meet with a certain resistance, after which they move off laterally, and finally pass around and arrange themselves in rear of the moving body. It is evident that the difference of the densities, or pressures, front and rear, depends on the velocity with which the displaced particles rearrange themselves after displacement; and this in turn depends on the shape and extent of the surfaces of the moving body. The best form for a projectile can only be determined by experiment, as theory and experiment do not agree in their results. According to theory, if a plane of given area be moved through the air, it meets with a resistance which is proportional to the square of the sine of the angle which its direction makes with that of motion.

The experiments of Hutton with low velocities show that this is only true in cases of 0° and 90°; that from 90° up to 50° or 60° the resistance is nearly proportional to the sine; beyond this it decreases a little more rapidly than the sine, but not so rapidly as the square of the sine:

For an angle of 22° it is only ½ }
14° " " " ⅓ }
9¼° " " " ¼ } the resistance proportional to the sine.
4° " " " ⅕ }
2° " " " ⅙ }

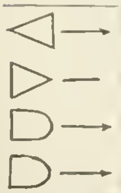
The following are the results of the experiments made by Hutton and Borda on the resistances experienced by different forms of solids moving through the air with velocities varying from 3 to 25 feet per second:

HUTTON'S EXPERIMENTS. VELOCITY, 10 FEET.



Kind of surface.	Experimental resistance.	Theoretical resistance.
No. 1, Hemisphere (convex surface in front)	119	144
No. 2, Sphere	124	144
No. 3, Cone, elements inclined to the axis 25° 42′	126	53
No. 4, Disk	285	288
No. 5, Hemisphere (plane surface in front)	288	288
No. 6, Cone (base in front)	291	288

BORDA.



Kind of surface.	Experimental resistance.	Theoretical resistance.
No. 1, Prism, with triangular base	100	100
No. 2, " "	52	25
No. 3, " semi-ellipse	43	50
No. 4, " ogee	39	41

The foregoing experiments show: 1st. That the results of theory do not agree with those of practice. 2d. That rounded and pointed solids suffer less resistance from the air than those which present flat surfaces of the same transverse area; but at the same time the sharpest points do not always meet with the least resistance. 3d. That where the front surfaces were the same the resistance was least with those in which the posterior surfaces were the flattest. 4th. That the ogeeval form, or the form of the present rifle-musket bullet, experiences less resistance than any of the others tried.

These experiments, as before remarked, were made with low velocities compared to those which ordinarily actuate projectiles, and the conclusions which have been drawn from them may not be strictly applicable in practice. Now that oblong projectiles are used in all kinds of fire-arms, it is important to determine that form which will be least affected by the resistance of the air. See *Projectiles*.

FORT.—A term technically applied to an inclosed work of the higher class of field-fortifications; but the word is often used in military works much more loosely. Detached works, depending *solely on their own strength*, belong to the class of works termed forts, and should have a revetted scarp and counterscarp of sufficient height to present great difficulties to an open assault, and have their ditches flanked either from the parapet of the work itself, or by caponieres, or by counterscarp-galleries. Their principal use is to occupy ground like commanding heights, which, although not within good sweep of the fire of the main work, is still within range of the heaviest calibers of the assailant, and which if occupied by him would prove a source of serious annoyance to the work. These detached works are also sometimes called *independent defensible works*, or simply independent works. In British North America the term *fort* is applied to a trading-post in the wilderness with reference to its indispensable defenses, however slight, against the surrounding barbarism. It has thus been often employed to designate merely a palisaded log-hut, the central oasis of civilization in a desert even larger, it may be, than Scotland. See *Advanced-works* and *Fortification*.

FORT ADJUTANT.—An officer holding an appointment in a fortress—where the garrison is often composed of drafts from different Corps—analogous to that of Adjutant in a Regiment. He is responsible to the Commandant for the internal discipline, and the appropriation of the necessary duties to particular Corps. Fort Adjutants are Staff Officers, and so receive a certain allowance per day in addition to their ordinary regimental pay.

FORTALICE—FORTELACE.—A small outwork of a fortification. The military power of the State is intrusted by the Constitution of England to the Sovereign. After having been unconstitutionally claimed by the Long Parliament in the time of Charles I., it was again vindicated for the Crown. This branch of the royal prerogative extends not only to the raising of armies and the construction of fleets, but to the building of forts, fortalices, and all other places of strength. Sir Edward Coke lays it down that no subject can build a house of strength embattled without the license of the King; and it was enacted by Henry VII. that no such place of strength could be conveyed without a special grant.

FORTIFICATION.—The records of history and the vestiges of remote civilization show that the art of fortification, in some guise or another, has been in practice throughout all nations, even in the lowest stages of social progress, and that, wherever it has been cultivated, its character has been more or less influenced not only by the natural features of the country, but by the political and social conditions of its inhabitants. There are three distinct epochs; namely, ancient, that of the Middle Ages, and modern. In its earliest applications, we find men resorting to one or more simple inclosures of earthen walls; or of these surmounted by stakes placed in juxtaposition; or of stakes alone firmly planted in the ground, with a strong wattling between them; or of timber in its natural state, having its branches and the undergrowth strongly interlaced to form an impervious obstruction, with tortuous paths through it only known to the defense. A resort to such feeble means shows not only a very low state of this branch of the military art, but also of that of the attack; as defenses of this kind would present but a slight obstacle, except against an enemy whose habitual mode of warfare was as cavalry, or of one not yet conversant with the ordinary plans for scaling. This class of fortifications for the defense of entire frontiers has been mostly met with in the east of Europe, and was doubtless, at the time, found to be a sufficient protection against those nomadic tribes that for ages have

FORTIFICATION. 1. *a, b,* Outline and profile of a lunette. *Intrenchments:* 2. Flèche. 3. Lunette. 4. Single redoubt and [illegible] 5. Tenailled line. 6. Horn-work. 7. Crown-work 8 Quadrangular redoubt. 9. Sexagonal redoubt. 10. Triangular redoubt, with semi-bastions. 11. Star redoubt. 12. Cross redoubt. 13 to 16. Forms of intrenchments 17. [illegible] and embrassures; *a,* Raised embrassure; *b,* deep embrassure, with reveted cheeks; *c,* with unreveted cheeks. 18 Oblique embrassures. 19 *a, b,* Ground plan and profile of a parapet. 19 *c,* Profile of parapet protected by gabions [illegible] Platform. 21. Scarp. 22. Sand-bag scarp. *Obstacles.* 23. Cheval-de-frise. 24 *a, b,* Snare and round Trous-de-loups (Wolf-traps). 25. Palissades, with ditch. 26. Stockade, with empalement. 27. Common palissades [illegible] palissade closed by cheval-de-frise. 29. Fraising an obtuse angle 30. Different modes of fraising. 31. Wire-fence. 32. Abattis. 33. Caltrops or Chausse-trapes. 34. Mine. 35. Mode of conveying fire to mine (fusée). [illegible] 37 *a.* Trap. 37 *b.* Percussion discharger for mine. 38. Location for mines. 39. Stone mine. 40. Block house. 41. Gallery "covering" ditch. 42. Redoubt, with caponnières covering ditch. 43. Barricade and stone-[illegible] open ground. 44. Residence fortified. 45. Garden wall arranged for fortification. 46 Tamboured gate. 47. Fortified village. 48. Tête-du-pont or Bridge-head. 49. Fortified forest. 50 Profile and construction of breast-w[illegible] Passage through an earth-line. 52. Passage through a barricade. 53. Breast-works ambuscaded with hedges 54 Wet ditch, with branches as barricades. 55. Bomb-proof earthwork. 56. Powder magazine 57 Breast-w[illegible] ramp 58 Heavy breast-works (of tree-trunks) on stony ground. 59. Gabion on parapet. 60. Fascine on parapet. 61. Earth-works, one-quarter, one-third, one-half, entire, double, triple. 62, 63. Tents. 64. Cook's pit. [illegible] loop-holes. 67. Platform, with gun in place. 68 Open space. 69. Dead angle.

roamed over its vast plains, and who are only formidable as a mounted force. The next obvious, and, in humid countries, necessary step, was to form walls either of rough blocks of stone alone, or of these interlaced with the trunks of heavy trees. Obstructions of this kind could only be used to a limited extent, and were confined to the defenses of places forming the early centers of population. As human invention was developed, these, in their turn, were found to present no serious obstacle to an assault by escalade; giving to the assailed only the temporary advantage of a more commanding position; and they gave place to walls of dressed stone, or brick, whose height and perpendicular face alike bade defiance to individual attempts to climb them, or the combined effort of an escalade. From the tops of these inaccessible heights, sheltered in front by a parapet of stone, and, in some cases, by a covered corridor behind them, the assailed could readily keep at bay any enemy, so long as he could be attained by their missiles; but having reached the foot of the wall, he here found shelter from these, and, by procuring any cover that would protect him from objects thrown from above, could securely work at effecting a breach by mining. It was probably to remedy this defect of simple walls and towers, which at first were nothing more than square or semicircular projections built from distance to distance in the wall itself, that flanking towers were first devised, and which subsequently were not only inclosed throughout, but divided into stories, each of which was provided with loop-holes to flank the adjacent towers and the straight portions of the wall between them. Each tower could be isolated from the straight portion of the walls adjacent to it by an interruption at the top of the wall, over which a communication between the tower and wall could be established by a temporary bridge. These formidable defenses were, in their turn, found to be insufficient against the ingenuity and skill of the assailant, who, by means of covered galleries of timber, sometimes above ground and sometimes beneath, gradually won his way to the foot of the wall, where, by breaking his way through it, or by undermining and supporting it on timber props to be subsequently destroyed by fire, he removed the sole obstruction to a bodily collision with the assailed. These methods of assault were in some cases supported by means of high mounds of earth which were raised in an inclined plane towards the walls, and sometimes carried forward to them, from the top of which the assailant, by the erection of wooden towers covered with raw hides to secure them from being burnt, could command the interior, and, driving the assailed from the walls, gain a foothold on them by lowering a drawbridge from the wooden tower.

These changes in the attack led to new modifications in the defense, which consisted in surrounding the place by wide and deep ditches, of which the walls formed the scarp, the counterscarp being either of earth or revetted. This placed a formidable obstacle to the mode of attack by mining, and also to the use of earthen mounds, as these last had to be constructed across the ditch before they could gain sufficient proximity to the wall either to form a communication with its top, or to breach it by means of the battering-ram; the ditches also were filled with water whenever this obstruction could be procured, and when dry they formed a defile through which the assailed often sallied upon the assailant with success when found at a disadvantage in it. The gigantic profile often given to the fortifications of antiquity seems almost incredible, as well as their extent. In many cases a double wall of stone or brick was filled in between with earth, forming a wide rampart upon which several vehicles could go abreast. Not only was the space inclosed by some of these fortifications sufficient for the habitations, but ground enough was taken in to add considerably to the food of the inhabitants and cattle, for the long periods to which blockades were in many cases extended when all other means of reducing the place had failed. The wall built by the Romans between Carlisle and Newcastle to restrain the incursions of the Picts into the southern portions of the Island was 16 miles in extent, about 12 feet in height, and 9 feet in thickness. The extent and dimensions of this work sink almost into insignificance when compared with those of the celebrated wall of China, built to restrain the incursions of the Tartars. This structure is about 1500 English miles in length; has a height of 27 feet; its thickness at top is 14 feet. The lower portion of it is built of dressed stone, the upper of well-burned brick. It is flanked at distances of about 80 yards apart by towers in which iron cannon are found. In the great extent it embraces it necessarily crosses hills and valleys, and in many places important defiles. An examination of its parts has shown that in its plan there was an evident design to adapt it to those features of its site, as it is well thrown back to the rear of difficult passes; and at points where there is most danger to be apprehended from attempts of invasion there are several walls in succession. The mode of attack of fortified places resorted to by the ancients was reduced to settled rules, and brought to the highest state of perfection by the Greeks, about the epoch of Alexander the Great and the immediate successors to his vast conquests. An essential feature in it, whether in the sieges of inland fortresses or those on the seaboard, was to cut off all communication between the place and the exterior by hemming it in by sea and land with stationary forces, covered themselves by lines of intrenchments strengthened by towers, and, in the case of sea-coast places, also by fleets, from all assaults both from without and from the place invested. Having selected the portions of the place on which the attack was to be directed, a second line was formed parallel to the first, which was covered, and constructed of timber and wicker-work, and secured with raw hides to prevent its being set on fire. From this sheltered position, which served also the purpose of a lodging for the besiegers, the besieged were annoyed with missiles thrown from all the artillery known in that day, consisting of the ordinary bow, the cross-bow, and the various machines for projecting heavy stones and other projectiles. The defense was mostly of a passive character; the besieged trusting mainly to the strength of their defenses, under cover of which they resorted to all the means used by the besiegers for assailing the latter when they came within reach of their missiles; using cranes and other devices to seize upon the implements planted at the foot of the wall, and carrying out galleries of countermines to overwhelm the artificial mounds and their towers. The Romans evinced their decided military aptitude not only in the employment of the ordinary systematic methods of the attack and defense of fortified places, but in their application of the cardinal principle of mutual defensive relations between the parts of a fortified position, obtained by advanced and retired portions of the enceinte, and also in the adaptation of intrenchments to the natural features of the site, as shown in the fortifications of some of the permanent frontier camps of their military colonies. These principles have also been noticed in some of the fortified positions of India, which consist of a mural enceinte with the earthen ramparts flanked by round towers, and of round towers in advance of the enceinte connected with it by caponieres.

The remains of the structures raised for defensive purposes during the prosperous days of the Empire were probably the sole means of protection afforded to the inhabitants of the towns that still maintained a nucleus of population, until the rise of the Western Empire under Charlemagne; and it was the necessity felt by this conqueror not only of securing his conquests, but of checking the irruptions of the barbarous tribes along his extended frontier, which led him to erect *têtes-de-pont* on the frontier rivers, and a line of strong towers, for garrisons of a few men, upon the most inaccessible and prominent points of this frontier; the latter being a means which was subsequently resorted to for a like purpose in the Spanish Peninsula. Henry I. of Germany introduced a more important and more systematic addition to these permanent frontier defenses by surrounding the frontier towns and villages, occupied by military colonists, with walls and ditches, to secure them from such attacks as they might be exposed to, and subsequently adding a second line of strongholds within the frontier, by which an irruption through the frontier line might still be checked. During the general disorganization of States under the feudal system, the free cities, which depended for their defense on the burghers composing the different crafts, every individual who could maintain a few retainers in his pay, and the Clergy, even, resorted—each according to their separate views—to such means of defense as would best secure them from the attacks of others in a like condition, and would enable them to carry out that system of pillage which had become general among the nobles and other military chieftains. From this state of society sprang up those castles placed in the most inaccessible positions on the lines of communication which the little inland commerce that was still carried on was obliged to traverse. These were provided with every possible device for an obstinate passive defense, being surrounded by a wide and deep ditch, or moat, over which a drawbridge was the only communication to the main entrance, which was flanked by towers on the exterior, and closed with massive doors; the tortuous passage which led from them to the interior of the castle being further secured by a grated portcullis, which could be let drop at a moment's notice, to arrest a sudden assault. To these means were often joined, besides the ordinary measures of loop-holes and machicoulis in the walls and towers for annoying the assailant, a high interior tower, termed a keep, or donjon, which, commanding the exterior defenses, was also a watch-tower over the adjacent country. The keep, which was the last defensible point, was in some cases provided with a secret subterranean passage, having its outlet in some distant concealed spot, through which succor could be introduced into the beleaguered castle, and, in the last extremity, the garrison find safety in a stealthy flight. The fortifications of towns partook of the same characteristics as those of castles. From the old custom of assigning to the different burgher crafts, each of which had an independent military organization, the exclusive guardianship of portions of the enceinte, as well as their erection and repairs, great diversity, and frequently a whimsicality, in the defensive arrangements was the natural result; the evidence of which still exists in the remains of the walls of some of the old Continental cities. The art, for the most part, was practiced by ambulatory engineers, who, like the secret orders by whom the bridges and churches of the same period were built, offered their services wherever they were wanted. Many ideas were also introduced from the East by the Crusaders, as exhibited in the fortifications of castles and cities belonging to the Templars and other religious military orders.

With the invention of gunpowder and its application to military purposes, a gradual revolution took place in the general forms and details of fortification. It was soon seen that naked walls alone did not offer either suitable conveniences for the new military machines, or sufficient protection against the projectiles thrown from them. This led to the introduction of earthen ramparts and parapets, which were placed against the walls and suitably arranged to meet the exigencies of the moment. The art received something like a scientific basis about this time in Italy, from which the names and forms of most of the elements of fortification now in use are derived. The Italian engineers, like their predecessors, went from State to State to offer their services wherever they were needed, and in this way disseminated the principles of their School throughout Europe. It was at this epoch that the bastioned form of fortification first appeared, but the precise date and the author of the invention are both unknown. With its introduction the importance of separating the parts of a line of fortification into advanced and retired parts, the latter flanking and defending the former, seems to have been recognized as an essential principle of the art. With these changes in the form of the enceinte, the art was gradually improved by the addition of the outworks to increase the amount of cross- and flank-fire; the introduction of bomb-proof shelters for the troops and other purposes; the substitution of earthen for stone parapets; and the attempt to conceal the scarp-walls from the enemy's batteries by decreasing the command and deepening the ditches of the enceinte. By these gradual changes stone walls, which in the old fortifications were the essential defensive features, came at length to be regarded in their true character, simply as passive obstacles to an open assault by escalade. The property of earthen parapets, of resisting without material loss of strength the long-continued fire of the assailant's heaviest guns, showed that the same defensive means were applicable both to work of a permanent and of a temporary character; and were equally available for the purposes of the assailant and the assailed. The measures for the attack and the defense of positions were thus reduced to the same general principles, differing only in the forms and dimensions of the elementary parts, as circumstances seemed to demand. From the discussions of and the variations made in the bastioned system by engineers of this period, there arose *four* distinct Schools of Fortification—the Italian, Dutch, French, and Spanish, all belonging to this system. As above stated, the first employment of bastions as they now exist was made by the Italian engineers, and, as far as has been ascertained, towards the close of the fifteenth or the commencement of the sixteenth century. To whom the credit of their invention is due is not known. In the earlier fronts of the Italian School the bastions are very small, and they are connected by curtains varying from 250 to 500 yards in length. The bastion flanks, which were perpendicular to the curtains, were divided into two portions; that next to the curtain, which was one third of the entire flank, was thrown back and covered by the portion in advance, which thus formed what received the name of the orillon. The lower part of the retired portion was casemated for cannon; and behind this, and separated from it by a dry ditch, rose a second flank, having the same command as the other parts of the enceinte parapet. In some cases a small and very obtuse bastion was erected at the middle of long curtains. The defects of these early fronts were soon felt, and a more complicated but improved method adopted, in which the bastions were enlarged and the curtains diminished. The retired flanks were still retained, but the orillon instead of being angular was rounded. To these improvements, cavaliers were sometimes added to the bastions, which in those cases were made without retired flanks; or placed on the curtains, when, from the configuration of the site, some portion of the ground within cannon-range could not be swept from the enceinte parapet. The covered-way was introduced and became an integral part of the front; and a small demi-lune or ravelin was placed in advance of the enceinte ditch, forming a *tête-de pont* to cover the communication, at the middle of the curtain across the main ditch, between the enceinte and the exterior.

The Dutch School took its rise in the political necessities of the times in which the national spirit was aroused to throw off an onerous foreign yoke. The aquatic character of the country, and the want of time and pecuniary means, led to those expedients of defense which are never wanting under like circumstances. The deficiency of earth led to the formation of low parapets for the main enceinte and wide ditches filled with water. The main enceinte was usually preceded by a second one with a very low parapet to sweep the surface of the wet ditch; and this second enceinte was separated from the first by a dry ditch, which favored sorties, and which was provided with all the means, as palisades, tambours, and block-houses, for offensive returns and surprises. The second enceinte was generally covered from an exterior command by a glacis in advance of the main ditch. The covered-way between the glacis and the ditches was, to a great extent, deprived of its essential offensive feature by an exterior wet ditch made at the foot of the glacis and inclosing it, over which communication with the exterior was kept open by temporary bridges. The works were usually very much multiplied and their combination complicated; features the less objectionable where their defense chiefly rested upon the inhabitants who had become familiar with all their turnings, and as offering obscurity of design to an assailant who might force his way into them. The whole of the defensive measures of this School seem to have had solely for their object a strictly passive resistance. With this view long lines of intrenchments, supported from distance to distance by forts, connected their frontier towns and villages, affording a sufficient obstacle to marauding expeditions, and requiring the efforts of a strong force to break through them. What may be termed the characteristics of the French School are to be seen rather in the method of Cormontaigne than in the practice of Vauban, although his authority has exercised a preponderating influence throughout Europe, and is still appealed to, in all great problems of the art, by each side in polemical disputes. This School is characterized by the retention of the profile of the Italian School, combined with the outworks of the Dutch, and a systematic arrangement of all the parts. The French have evinced in this, as in all the other arts, that spirit of systematic combination which forms one of their most striking national traits. From the existing fortifications of Spain the influence of the Italian School may be traced, but modified by national characteristics. The works seem organized more for a purely passive defense; the covered-way, that essential outwork to an active defense, being in many cases omitted, the means of annoying the besiegers by fires being greatly multiplied, and the outworks generally being arranged with a view to a purely passive defense. Besides this, the dimensions of the profile and height of scarp were increased as a greater security against escalade; interior retrenchments were multiplied, sometimes inclosing a bomb-proof keep to render the defense more obstinate. The Spaniards, although resorting but little to sorties, show great skill and pertinacity in the defense of breaches, and in availing themselves of all obstructions for prolonging resistance.

The combinations adopted in fixing the defensive relations, and the proportions of the various parts of the bastioned system, produced a great many methods of fortification. These differ so little in plan from those that characterize the four Schools just named, that they may all be placed under the head of one or the other of these classes. It has been observed how the natural features of the country, like Holland, and the national characteristics of the people, like the Spanish, have modified the plan and profile of their works. This is particularly true in Sweden, and partly so in Germany. We may then form two other Schools based on these peculiarities —that of Sweden and that of Germany. The part played by Sweden upon the theater of Europe, under her two celebrated Monarchs, Gustavus Adolphus and Charles XII., served to develop in this nation every branch of the military art, and produced a number of distinguished Generals and Engineers, who combined, with the practice of their profession, a study of its theory. Among the engineers of this School, Virgin holds the first place. The climate and the nautical habits of the country seem to have led to land-defenses analogous to those of ships, as shown in the uses of casemated batteries in several tiers, both for sea-coast and inland fortifications. In this School the bastioned system seems to have been generally adopted for the enceinte, great attention being paid to covering the faces of the works from enfilading fire; in providing casemates having reverse views on the besieger's works; and particularly in so arranging the interior dispositions that each part should not only contribute to the defense of the others, but be capable of an independent resistance. These dispositions necessarily led to great complication and multiplicity of works, as shown in the writings of Virgin. The Germans reckon a number of original writers on fortification, among the most noted of whom are the celebrated painter Albert Dürer, Daniel Speckle, and Rimpler. In the propositions of these writers are to be found the influence which the Italian School naturally exercised throughout civilized Europe, and the germs of many of the views held by the German School of the present day; which last seem, however, to have been taken more immediately from the propositions of Montalembert and Carnot.

The introduction of cannon, although it led to important changes in the measures both of the attack and defense, still did not, for a considerable period, bring about any very decisive results in the length of sieges. The means which it afforded the defense of reaching the besiegers at a distance, and of destroying all the methods of approaching and annoying the place which had hitherto been used, led to the substitution of the ordinary trenches of the present day for the wooden galleries and other similar expedients for approaching under cover, and to the erection of batteries at distant points to open breaches in the walls. Lines of circumvallation and countervallation, which formed so prominent a feature previously to this epoch, was the only one which still kept its place, as it has done to a greater or less extent to the present day. For the purpose of effecting an entrance into the place, breaching-batteries were erected opposite the points deemed most favorable. They were placed either on natural elevations of the ground or upon artificial mounds, with the object of attaining the wall to be opened near its foot, and to form a breach of easy ascent. These batteries were enclosed in works of sufficient size and strength to hold garrisons to secure them from sorties. The approaches were made as at present, by zigzags along the capitals of the salients to the counterscarp, where a covered descent was made into the ditch opposite the breach preparatory to its assault. When the wall was not exposed to a distant fire, the besiegers were obliged to carry the covered-way by assault, and establish their breaching-batteries on the crest of the glacis. In carrying forward these works the besiegers were subjected to great losses and delays, owing to the magnitude and the multiplicity of the works they were obliged to complete; to the imperfect character of their artillery and the faulty position of their batteries, by which they were unable to keep under the fire of the place; the want of connection between the separate approaches, and the consequent exposure of the workmen in the trenches to sorties, the troops for their support being too distant in the inclosed works in the rear to give them timely succor; besides which, as these inclosed works naturally became the chief objects for the fire of the besieged, this agglomeration of troops in them added materially to the losses of the besiegers. Owing to these imperfections in the measures of attack, the besieged were able to make a vigorous and prolonged defense; and sieges became the most important military operations of this period, in which Captains of the greatest celebrity sought for opportunities of distinction.

But little deviation was made in the methods just described until Vauban appeared upon the scene. Previously to him, Monthic, a distinguished French General and Engineer of his day, had introduced short branches of trenches, which were run out from the angles of the zigzags, to post a few troops for the immediate protection of the workmen; but these were found to be very insufficient in repelling sorties of any strength. The event which seems to have had the greatest influence on the subsequent progress of both the attack and defense was the memorable siege of Candia, in which volunteers from all parts of Europe engaged, and who, after its close, disseminated throughout their respective countries the results of the experience they had there acquired. Whether the idea of the parallels, now in use in the attack, originated there, or with Vauban, this eminent man was the first to establish them in a systematic manner, and to demonstrate by experience their controlling importance in repressing sorties. The introduction of this important element in the attack; the concentration of the fire of batteries, by giving them enfilading positions; the invention of the ricochet, as the most powerful destructive means against the defenses; the avoidance of open assaults, which, even when successful, are made at a great sacrifice of life, preferring to them the less brilliant but slower method of skill and industry, by which the blood of the soldier is spared, and the end the more surely attained, such are the important services which the attack owes to Vauban, which has given it its present marked superiority over the means of defense, and to which the science and experience of engineers since his day have added nothing of marked importance.

From this brief summary, it will be seen that the art of fortification, in its progress, has kept pace with the measures of the attack; its successive changes having been brought about by changes either in the arms used by the assailant, or by the introduction of some new mode of assault. The same causes must continue to produce the same effects. At no past period has mechanical invention, in its bearing on the military art, been more active than at the present day. The improvement that has already been made in the range and accuracy of aim of both small-arms and cannon, the partial adoption of wrought-iron and steel for floating batteries and sea-coast defenses, point to the commencement of another epoch in the Engineer's art. The great improvement in cannon will give to the assailant a still wider range in the selection of positions for his batteries, and will thus increase the difficulties of the engineer in adapting his works to the site, and in giving adequate shelter to the garrison and armament. Whilst the defense will be to this extent weakened, the approaches of the besieger will be rendered more perilous and more difficult from the greater range and accuracy of small-arms. Upon the chief defects and wants of the art there exists but slight divergence of opinion among engineers generally; not so with respect to the remedy; opposite opinions being frequently drawn from the same class of facts, and the same authority being frequently cited to sustain opposite views. Whilst each new disputant denounces systematizing and the systems of others, his remedy for the abuse complained of is usually a system of his own, which not unfrequently is but a combination of the *disjecta membra* from those of others. See *Castle*, *Enceinte*, *Field-fortification*, *Permanent Fortification*, and *System of Fortification*.

FORTIFICATION-DRAWING. — The method now in general use, among military engineers, for delineating the plans of permanent fortifications is similar to the one which had been previously employed for representing the natural surface of ground in topographical and hydrographical maps, and which consists in projecting, on a horizontal plane at any assumed level, the bounding lines of the surfaces and also the horizontal lines cut from them by equidistant horizontal planes, the distances of these lines from the assumed plane being expressed *numerically* in terms of some linear measure, as a yard, a foot, etc. The assumed horizontal plane upon which the lines are projected is termed the *plane of comparison* or *plane of reference*, as it is the one to which the distances of all the lines from it are referred, and as it serves to compare these distances with each other and also to determine the relative positions of the lines.

The numbers which express the distances of points and lines from the plane of comparison are termed *references*. The unit in which these distances are expressed is usually the linear foot and its decimal divisions. As the position assumed for the plane of comparison is arbitrary, it may be taken either above or below every point of the surfaces to be projected. In the French military service it is usually taken above, in our own below the surfaces. The latter seems the more natural and is also more convenient, as vertical distances are more habitually estimated from below upwards than in the contrary direction. Each of these methods has the advantage of requiring but one kind of symbol to be used, viz., the numerals expressing the references; whereas, if the plane of comparison were so taken that some of the points or lines projected should lie on one side of it and some on the other, it would be then necessary to use, in connection with the references, the algebraic symbols *plus* or *minus* to designate the points above the plane from those below it. As the distances of all points are estimated from the plane of comparison, the reference of any point or line of this plane will therefore be zero (0.0); that of any point above it is usually expressed in feet; decimal parts of a foot being used whenever the reference is not an entire number. When the reference is a whole number it is written with one decimal place, thus (25.0); and when a broken number with at least two decimal places, thus (3.70), (15.63). In writing the reference the mark used to designate the linear unit is omitted, in order that the numbers expressing references may not be mistaken for those which may be put upon the drawing to express the horizontal distances between points. The references of horizontal lines are written along and upon the projections of these lines. All other references are written as nearly as practicable parallel to the bottom border of the drawing, for the convenience of reading them without having to shift the position of the sheet on which the drawing is made.

This method of representing the projections of objects on one plane alone has given rise to a very useful modification of the one of orthogonal projections on two planes, and has been denominated *one-plane descriptive geometry;* the plane of comparison being the sole plane of projection, and the references taking the place of the usual projections on a vertical plane. By this modification the number of lines to be drawn is less; the graphical constructions simplified; and the relations of the parts are more readily seized upon, as the eye is confined to the examination of one set of projections alone. But the chief advantage of it consists in its application to the delineation of objects, like works of permanent fortification, where, from the great disparity of the horizontal extent covered and the vertical dimensions of the parts, a drawing, made to a scale which would give the horizontal distances with accuracy, could not in most cases render the vertical dimensions with any approach to the same degree of accuracy; or, if made to any scale which would admit of the vertical dimensions being accurately determined, would require an area of drawing surface, to render the horizontal dimensions to the same scale, which would exceed the convenient limits of practice. Taking for example an ordinary scale used for drawing the plans of permanent fortifications of *one inch* to *fifty feet*, or the scale $\frac{1}{600}$, the details of all the bounding surfaces can be determined with accuracy to within the fractional part of a foot, whereas a vertical projection to the same scale would be altogether too small for the same purposes.

For the convenience of numerical calculation, the position of a line, with respect to the plane of reference, is often expressed in terms of the natural tangent of the angle it makes with this plane; but as this angle is the same as that between the line and its projection, its natural tangent can be expressed by the difference of level between any two points of the line, divided by the hoirzontal distance between the points. Now, as the difference of level between any two points of the line is the same as the difference of the references of the points, and the horizontal distance between them is the same as the horizontal projection of the portion of the line between the same points, it follows that the natural tangent of the angle which the line makes with the plane of reference is found *by dividing the difference of the references of the points by the distance in horizontal projection between them.* The vulgar fraction which expresses this tangent is known as the *inclination* or *declivity* of the line. Thus the fraction $\frac{1}{6}$ would express that the horizontal distance between any two points is six times the vertical distance, or difference of their references; the fraction $\frac{2}{3}$, that the vertical distance between any two points is two thirds the horizontal distance; *the denominator of the fraction*, in all cases, *representing the number of parts in horizontal projection, and the numerator the corresponding number of parts in vertical distance.* When the position of a line is designated in this way, it is said to be a line whose inclination or declivity is one sixth, two thirds, ten on one, etc., or simply *a line of one sixth*, etc.

Knowing the declivity of a line, the difference of reference of any two of its points, the projections of which are given, will be found by multiplying the horizontal distance between them by the fraction which expresses this declivity; in like manner the horizontal distance of any two points will be obtained by dividing the difference of their references by this fraction. To obtain, therefore, the reference of a point of a line, having its projection, the horizontal distance between it and that of some other known point of the line must be determined from the scale of the drawing by which the horizontal distances are measured; this distance expressed in numbers, being multiplied by the fraction which expresses the declivity of the line, will give the difference of reference of the two points; the required reference of the point will be found by subtracting this product from the reference of the known point, if it is higher than the point sought, or by adding if it is lower.

When the projection of a line is divided into equal parts, each of which corresponds to a unit in vertical distance, and the references of the points of division are written, it is termed *the scale of declivity of the line.* In constructing the scale of declivity of any line, the entire references are alone put down; one of the divisions of the equal parts being subdivided into tenths, or hundredths if necessary, so as to give the fractional parts of the references corresponding to any fractional part of an entire division. The true length of any portion of an oblique line between two given points is evidently the hypothenuse of a right-angled triangle of which the other two sides are the difference of reference of the points, and their horizontal distance.

The position of any plane oblique to the plane of reference may be determined either by the projections and references of three of its points; by the projections and declivity of two lines in it oblique to the plane of reference; or by the projection of two or more horizontal lines of the plane with their references. The more usual method of representing a plane is by the projections on the plane of reference of the horizontal lines determined when intersecting it by equidistant horizontal planes. These projections are termed *horizontals of the plane*, those usually being taken the references of which are entire numbers. If in a given plane a line be drawn perpendicular to any horizontal line in it, the projection of this line on the plane of reference will be also perpendicular to the projections of the horizontals. The angle of this line with the plane of reference is evidently the same as that of the given plane with it, and is greater than the angle between any other line drawn in the plane and the plane of reference. This line is, on this account, termed *the line of greatest declivity* of the plane. If the scale of declivity of the line of greatest declivity be constructed, it will alone serve to fix the position of the plane to which it belongs, and to determine the reference of any point of the plane of which the projection is given. For, since the horizontals are perpendicular to the scale of declivity, the point where the horizontal drawn through the given projection of a point in the plane cuts this line will determine upon the scale the reference of the horizontal, and therefore that of the point.

The inclination or declivity of any plane with the plane of reference may be expressed in the same way as the inclination of its line of greatest declivity. Thus *a plane of one fourth, a plane of twenty on one, a plane of two thirds*, express that the natural tangents of the angle between the planes and the plane of reference are respectively represented by the fractions $\frac{1}{4}$, $\frac{20}{1}$, and $\frac{2}{3}$. The horizontal distance between any two horizontal lines in a plane, the angle of which is given, can be found in the same way as the horizontal distance between two points of a line, the inclination of which is given, by dividing the difference of the reference of the two horizontal lines by the fraction representing the declivity of the plane; in like manner the difference of references of any two horizontal lines will be obtained by multiplying their horizontal distance by the same fraction. With the foregoing elements the usual problems of the right line and plane can be readily solved. See *Drawing.*

FORTILAGE.—The name formerly given to a little fort or block-house. The word is now obsolete, as also the word *fortin*, used in the same sense. *Fortlet* is commonly used at present.

FORT MAJOR.—The next officer to the Governor or Commandant in any fortress. He is expected to understand the theory of its defenses and works, and is responsible that the walls are at all times in repair. He is on the Staff, but has to resign his regimental appointment, and receives an addition to his half-pay.

FORWARD.—The word of command given when troops are to resume their march after a temporary interruption.

FOSS—FOSSE.—In fortification, the ditch or moat, either with or without water, the excavation of which has contributed material for the walls of the fort it is designed to protect. The foss is immediately without the wall, and offers a serious obstacle to escalading the defenses.

FOSSANO POWDER.—The "progressive powder of Fossano," made at the Italian powder-mills of Fossano, is of peculiar manufacture. After passing through the first stage of manufacture, and being brought to the condition of *meal-powder*, it is pressed into a cake which has a density of 1.79. The cake is then broken up into irregular grains of about an eighth to a quarter of an inch in thickness. The grains are then mixed with a certain quantity of fine-grain powder, and the whole mass is pressed into a cake which has a density of 1.75. This second cake is then broken up into tolerably regular pieces about $2\frac{1}{8}$ inches square by $1\frac{3}{4}$ inches thick. These grains are therefore composed of a number of small pieces with a higher density placed in a sort of conglomerated powder-material of a lower density, the intention being to produce more gas in a given time, when the powder has been partly burned, than at the commencement of its ignition. This is accomplished by the lighter powder igniting first and producing inequalities or indentations in the grains, when the denser portions will burn with an increasing surface. The Fossano powder has given remarkably high velocities with moderate pressures, and has the great merit of cheapness and simplicity. See *Gunpowder.*

FOSSEWAY.—One of the military Roman roads in England, so called from the ditches on both sides.

FOTHERGILL PROCESS.—This is one of the numerous dry processes in photography which have for their object the preservation of sensitive plates ready for exposure. It is named after the inventor, and consists in the partial removal of the free nitrate of silver which adheres to the collodion film on withdrawing it from the sensitizing bath by washing with water, and the subsequent conversion of the remaining free nitrate of silver into albuminate and chloride of silver by pouring over the plate dilute albumen, containing chloride of ammonium, the excess of albumen being finally washed off by violent agitation with a copious supply of water. The plates being set aside to drain on folds of blotting-paper are, when thoroughly dry, ready for use. See *Photography*.

FOUCADE.—A term formerly and very commonly applied to a small mine. Also written *Fougade*.

FOUGASSES.—Mines are so called when placed at the bottom of small shafts from 9 to 12 feet deep. The powder is lodged in one of the sides of the shaft, and it is fired from a secure spot by means of a powder-hose train, brought up one side of the shaft, and carried in a trough, parallel to the ground, 5 or 6 feet below the surface. When there is no occasion to fear that shells may fall on the part where the trough is laid, it will be sufficient to place it 2 or 2½ feet under the ground. The powder-case and trough should be well pitched, the shaft tamped in the strongest manner, and the earth round about the shaft be dug over, that nothing may indicate to the enemy the position of the fougasse.

The chief difficulty attending the use of fougasses is to explode them at the instant when the enemy is passing over, as any variation in the time of explosion from this instant renders them useless. It is recommended to place an obstacle over them, as an abatis or chevaux-de-frise, so that the fougasses may be exploded while the enemy is occupied in forcing his way over. See *Shell Fougasses* and *Stone Fougasses*.

FOUGETTE.—An Indian sky-rocket, a species of fire-work which is frequently used by the Asiatics. It is made of the hollow tube of the bamboo, of a very large size, filled with the usual composition of rockets. The rod is only a part of the same bamboo, the greater part of which is cut away.

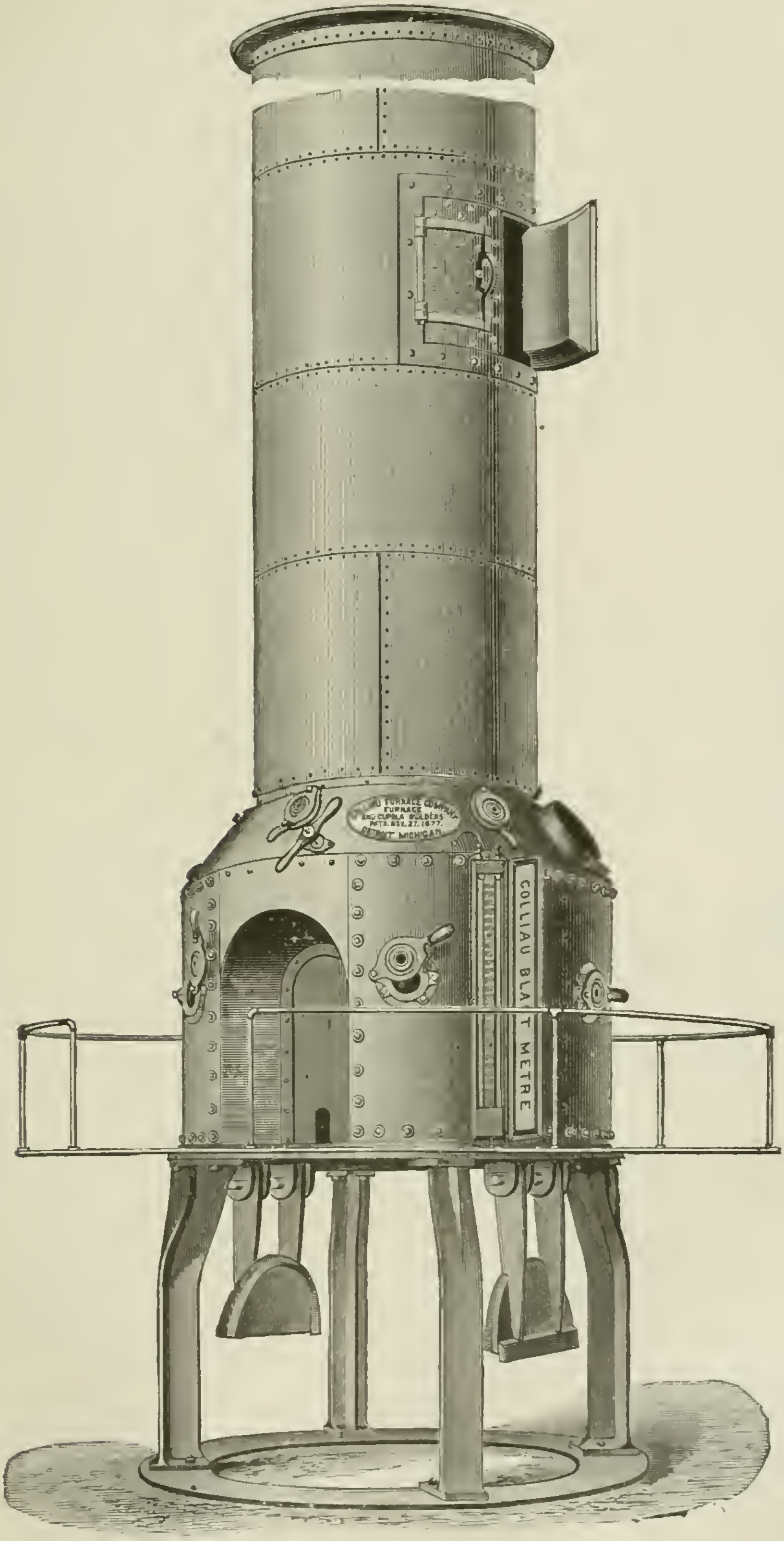
FOUILLER.—In a military sense, to detach small bodies of infantry round the flanks of a column that is marching through a wood, for the purpose of discovering an ambuscade, and of giving timely notice that it may be avoided. The same precaution is necessary when a body of men advance towards or enter a village.

FOULING.—Smoke is a solid product of the explosion in a fine state of division; but at the instant of explosion this product is liquid and a part of it cakes together in the bore and causes *fouling*. Each succeeding round, however, expels a good deal of that which was previously deposited. *Fouling* is more likely to occur in a small-arm than in a large piece of ordnance, and it is best prevented by the use of good powder in the charge and careful sponging. It gradually impairs the accuracy, sometimes makes the breech difficult to open, and increases the recoil, as the resistance to motion of the bullet in the bore becomes greater, and consequently the charge exerts its force for a longer time.

FOUNDATION.—The artificial structure on which the remainder of an edifice rests. The *body* of the foundation is the masonry or timber-work used; the *bed*, the prepared surface on which the body rests. The bed may be a leveled surface of rock, sand, or earth, consolidated by beating or by driving piles into it; if the tops of the piles are bound together by a flooring of timbers—called a grillage—this flooring is deemed the bed of the foundation. Rock is the best foundation, but its bearing power should be tested, and its upper surface should be made normal to the direction of the pressure. To avoid expense, the bearing surface may be left in steps, but the steps should be filled with well-fitted masonry, that there may not be undue settlement upon the filled side, in case the lowest step should be much lower than the highest. Great care should be taken to apportion the load to the supporting power of the foundation; if the latter be found inadequate, the area of the foundation should be increased until the weight distributed to each unit of surface shall be brought within the proper maximum. Engineering science has been severely tested by demands for sure foundations in places where the soil and substrata are by nature yielding, or exposed to the insidious action of running water, or where both evils are united. Except upon solid rock, settlement cannot be avoided. It is enough for the safety of the structure if the settlement can be made uniform in all its parts.

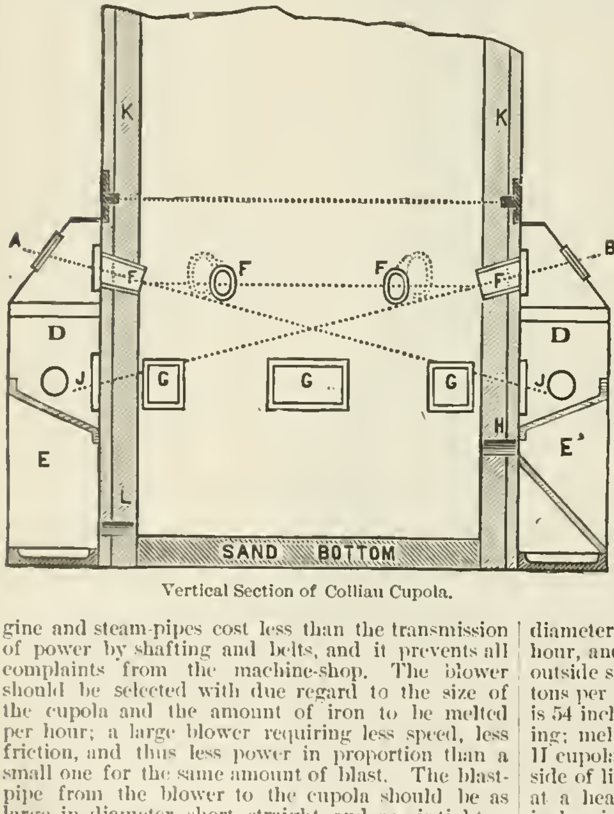
A method of constructing foundations in deep water adopted in late years is called the "pneumatic;" the manner of its application is either that of a "vacuum" or a "plenum," according as the pressure of the air within is below or above the usual pressure of the atmosphere. In either case, an iron cylinder, usually constructed in sections, is lowered into the water until its lower end rests on the bottom, while its upper end extends above the surface. If the vacuum process be used, the cylinder is capped, and an air-pump reduces the pressure of the air within. The weight of the tube with the atmospheric pressure on its head pushes it into the ground, while the water pressing in below the lower end stirs the earth and assists the descent. When descent stops, the air-pump may be reversed, and the water in the pipe will be slowly driven through the earth; a sudden release of the inner pressure will cause a second influx of water, a disturbance of the soil, and a further descent of the tube. If the earth contains bowlders or buried timbers, the movement of the tube may be stopped before reaching the depth desired by the Engineer; or he may wish to remove the interior earth and replace it with masonry, even where the ground is too gravelly to keep out the water. In this case an air-lock is placed upon the top of the tube, air is forced into the interior, driving out the water, and workmen are employed within to excavate the earth, and afterward to lay the masonry. The air-lock is a chamber which serves as a vestibule to the interior, and permits the maintenance of a nearly constant air-pressure within. A man enters the air-lock and closes the door behind him; he then opens communication with the interior of the tube, and when the pressure of air is equalized in the two spaces he passes within.

FOUNDRY.—The principal points to be considered in the erection of a foundry are the proper arrangement of plants for the economical handling of the iron and fuel, and the castings when made. The ground should be well drained, and if in the proximity of water, the lower floor should be several feet above the highest level of the water. The foundry-floor is filled with molding-sand, from five to ten feet deep. Sometimes it is necessary to have pits, made of boiler-iron, set in the ground, twenty to thirty feet deep, as in the car-wheel foundries, for the annealing process. The main building, used for the molding-room, should be at least twenty feet high in the walls, and should be well lighted, especially in the roof, by running a large sky-light the entire length of the building, and so arranged as to be easily opened for ventilation. Additional rooms should be provided for storing and preparing the materials of the molds, such as grinding and sifting the sand, loam, sea-coal, coke, plumbago and the charcoal, and likewise for cleaning the castings and milling them. There should also be a workshop for making patterns, and large ovens for drying the cores. The molding-room should have an area proportionate to the amount of work and kind of castings to be made. For example, the Detroit Car-wheel Company, Detroit, Mich., have a molding-floor with an area of about 10,000 square feet. They cast 360 wheels per day, melting 100 tons of iron. Barney & Smith, Dayton, Ohio, floor-area 6000 square feet, melt 50 tons of iron, making 170 car-wheels per day. Louisville Car-wheel Company, floor-area 9000 square feet, melt 50 tons of iron, making 170 car-wheels per day. Union Foundry and Pullman Car-wheel Works, Pullman, Ill. melt 125 tons of iron per day, making 160 wheels, besides other castings. Area of floor,



The Victor Colliau Cupola.—For Foundry Use.

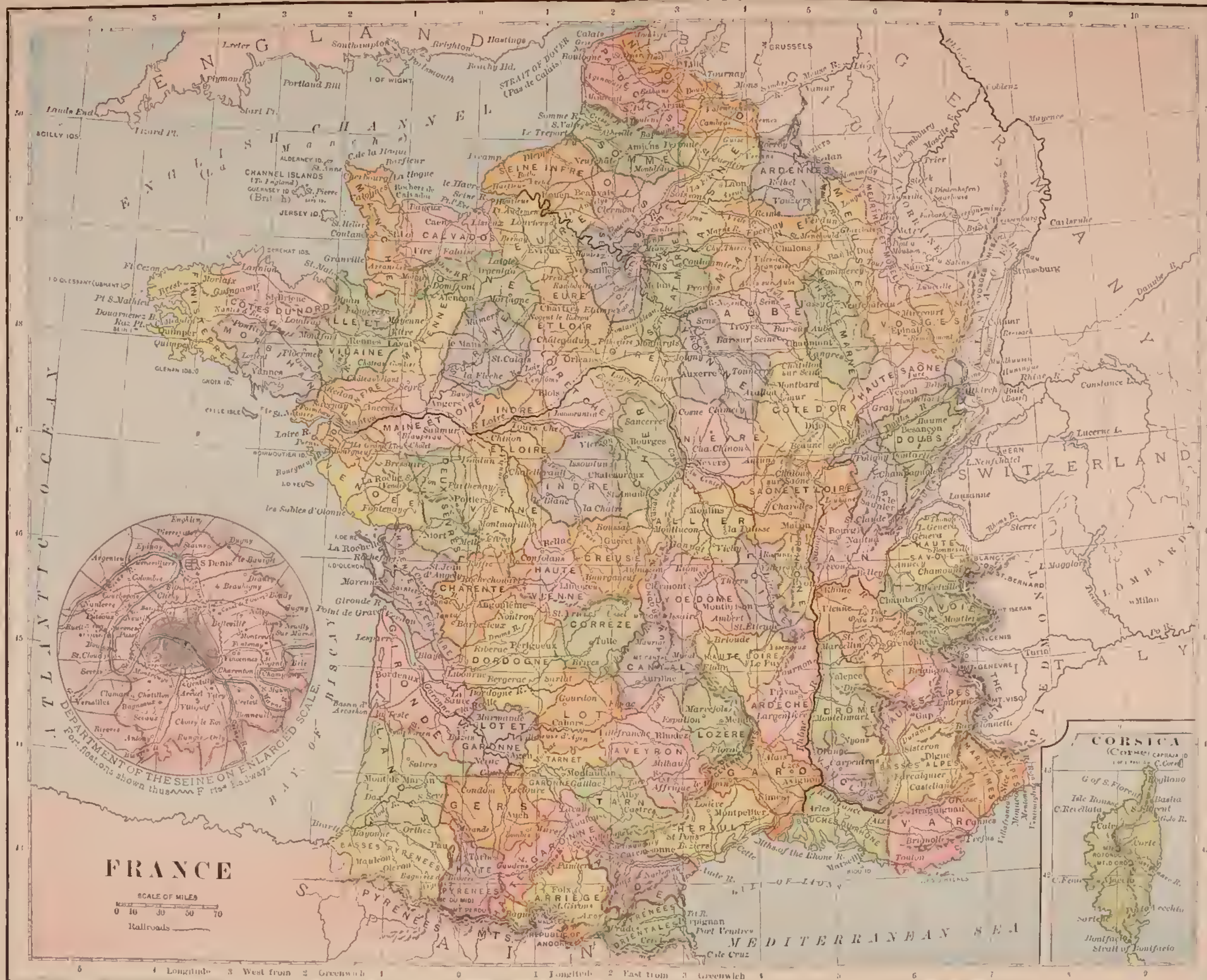
50,000 square feet. Walter A. Wood Harvester Company, Hoosick Falls, N. Y., melt 40 tons of reaper and mower castings per day. Area of floor, 18,000 square feet. A stove-foundry requires a very large floor-area. The cupolas should be placed as near the center of the building as possible, so as to equalize the distance for carrying the melted iron from the cupola to the molds. This is done very economically, for small castings, in ladles on wheels, running on rails, distributing the iron to small hand-ladles at each separate floor. For heavy castings large cranes are used, for lifting and moving molds and castings, and conveying the melted metal in large ladles. The cupolas should be outside of the molding-room, in a separate building, containing the cupola loading-floor, elevator (if inclined plane is not used), and a mill for cleaning the cupola-droppings. The height of the charging-doors above the bottom plate should be not less than 12 feet; 14 to 16 feet is better. It is a good plan to provide a separate steam-engine to run the blower. This is more economical even in the first construction, as the engine and steam-pipes cost less than the transmission of power by shafting and belts, and it prevents all complaints from the machine-shop. The blower should be selected with due regard to the size of the cupola and the amount of iron to be melted per hour; a large blower requiring less speed, less friction, and thus less power in proportion than a small one for the same amount of blast. The blast-pipe from the blower to the cupola should be as large in diameter, short, straight, and as air-tight as possible. Avoid all bends if possible; if not, make them as long and easy as circumstances permit.



Vertical Section of Colliau Cupola.

The foundry is the basis or starting-point of all machinery and heavy guns, and bad castings spoil the work. The foundry should receive as much, if not more, care and study as the machine-shop, and the best cupola should be used. The records of the Colliau cupola show the most economy in fuel and iron, the greatest rapidity in fusion, and the largest amount of iron melted in a given time and size, as well as the greatest quantity of iron melted at a heat in one cupola without clogging. This cupola is represented complete in the engraving on page 701. The accompanying drawing represents a vertical section. D D is the air-box, G G the lower tuyeres, F F the upper tuyeres. A B is the line of horizontal section, shown below the vertical section. E is the arch over the tap-hole, L. E′ is the arch over the slag-hole, H. The line from F to J shows the inclination of the upper tuyeres, F F. K is the inside brick lining. The peculiar features of the Colliau cupola are the proportions and arrangements of the upper and lower tuyeres. The six lower tuyeres are rectangular and are intended to furnish the air necessary to the combustion of the fuel. They are generally left open during the fusion; but as they are provided with gates inside the air-box, they can be shut more or less during the working, to direct the blast more on one side than the other if necessary, or may be closed altogether (in case of accident to the blower). The six upper tuyeres are round, and point downwards. They are arranged to alternate with the lower tuyeres. Their inclination is proportionate to the diameter of the cupola, in such manner that the blast from them will reach the focus of combustion produced by the lower tuyeres. The upper tuyeres are closed when the blast is turned on, and opened when the iron shows at the tap-hole, and the cupola plugged up to accumulate the first draught of iron. This is accomplished by moving the lever-handle which is shown on the top of the air-box in the figure. The opening of these tuyeres produces a downward blast of air (on the principle of a blow-pipe), and furnishes the oxygen necessary to the combustion of the hydrocarbon gas, which, without it, would be thrown off by the imperfect combustion of the fuel at the level of the lower tuyeres. This combined blast produces a melting-point about 18 inches above the upper tuyeres, and nowhere else, concentrating the heat in the smallest possible compass, so that the metal in fusion has less space to traverse while exposed to the oxidizing influence of the blast, thereby insuring tougher castings and more perfect combustion of the inflammable gases (with corresponding economy of fuel), which is contrary to the usual practice of spreading the blast as much as is possible. In the practical use of this cupola there is no flame at the loading-doors, and no throwing off of combustible gases, carbonic-acid gas (the only product of perfect combustion) alone escaping; little or no flame being seen at the top of the stack until the iron is about all melted. This cupola melts more iron per hour in proportion to its size than any other. B cupola is 73 inches outside diameter of shell, 58 inches diameter inside of lining; melts 12 to 15 tons per hour, and 100 tons at a heat. D cupola is 64 inches outside shell, 49 inches inside of lining; melts 8 to 10 tons per hour, and 50 to 60 tons at a heat. F cupola is 54 inches outside of shell, 42 inches inside of lining; melts 5 to 6 tons per hour, and 40 tons at a heat. H cupola is 47 inches outside of shell, 36 inches inside of lining; melts 4 to 5 tons per hour, and 30 tons at a heat. J cupola is 43 inches outside shell, 32 inches inside of lining; melts 3 to 4 tons per hour, and 20 tons at a heat. L cupola is 35 inches outside of shell, 25 inches inside lining; melts ½ to 1 ton per hour, and 4 to 5 tons at a heat. Meltings of 10 to 12 pounds of iron to 1 pound of fuel are obtained in this cupola, according to quantity of metal melted at a heat. One of the results of the Colliau cupola is a decrease of time in melting as the operation advances, that is to say, a better working of the cupola at the end of the operation than at the beginning; this is the reverse of what generally occurs in cupolas. See *Iron*.

FOUR.—A place of confinement in Paris to which vagabonds and persons who could not give any satisfactory account of themselves were committed; and when once shut up had their names registered, and were enlisted for the old French Government. These Fours added annually 2000 men at least to the King's regular army; and by which means the capital was relieved of a multitude of thieves, pickpockets, etc.


FRANCE
SCALE OF MILES
0 10 30 50 70
Railroads
ENGLAND
ENGLISH CHANNEL
BELGIUM
GERMANY
SWITZERLAND
ITALY
SPAIN
ATLANTIC OCEAN
BAY OF BISCAY
MEDITERRANEAN SEA
CORSICA
DEPARTMENT OF THE SEINE ON ENLARGED SCALE
CHANNEL ISLANDS
BRUSSELS
SCILLY IDS.
Longitude West from Greenwich
Longitude East from Greenwich

FOURAGE.—A term used figuratively in artillery, to signify hay, straw, or anything else of a vegetable growth which is used to ram into the bore of a cannon for the purpose of cleansing it.

FOURGON.—1. A tumbrel or ammunition-wagon. 2. A French baggage-vehicle, much used in the field.

FOURIER.—A Quartermaster belonging to a cavalry or infantry regiment. In France there were *Fouriers Majors* who composed a portion of the Cavalry Staff. *Sergeant Fourier* and *Corporal Fourier* answer to our Quartermaster Sergeant.

FOURNIMENT.—A horn formerly in use, which held about one pound of gunpowder, to prime cannon. It was likewise used by cavalry and infantry soldiers, who slung it across their shoulders. The artillerists kept it in a belt.

FOURQUINE.—A forked rest, furnished at its extremity with a point or spikes to fix it steadily in the ground. The musket was at first very considerably heavier than the arquebuse, and it was necessary to discharge it from a rest.

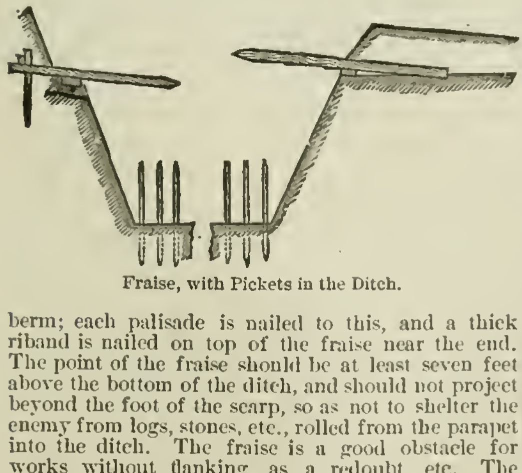
FOWKE'S PONTON.—This ponton is formed of a wooden skeleton, over which is strained strong canvas rendered water-proof. It can be used as a boat and is water-tight. It is readily transported and has a great buoyancy.

FOWLING-PIECE.—A light gun for shooting birds. In constructing the barrels of this sporting-weapon, the maker endeavors to secure the greatest possible lightness, but without detracting from the necessary strength. Formerly wrought-iron only was used, but cast-steel is now very generally preferred. The breech-loading principle has been introduced to a great extent, but many sportsmen are still in favor of the muzzle-loader. The manufacture of the best specimens of fowling-pieces demands a very high degree of mechanical skill.

FOX.—An early and common name given to the old English broadsword.

FRAISER.—To plait, knead, or to drill. In a military sense, to fraise or fence; as, *fraiser un battalion*, to fraise all the infantrymen with pikes, to oppose the irruption of cavalry, should it charge them in a plain. At present it means to secure a battalion by opposing bayonets obliquely forward, or crosswise in such a manner as to render it impossible for horsemen to act against it.

FRAISES.—These obstacles are formed of palisades, placed in juxtaposition, either horizontally or slightly inclined. The best position for a fraise is on the berm, or a little below it, so as to be covered by the counterscarp-crest. The part of the fraise under the parapet is termed the *tail*, and is about five feet long. To make a fraise, a horizontal piece of a four-inch scantling, termed a *cushion*, is first laid parallel to the

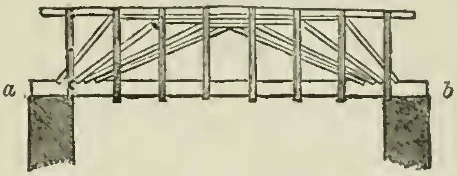


Fraise, with Pickets in the Ditch.

berm; each palisade is nailed to this, and a thick riband is nailed on top of the fraise near the end. The point of the fraise should be at least seven feet above the bottom of the ditch, and should not project beyond the foot of the scarp, so as not to shelter the enemy from logs, stones, etc., rolled from the parapet into the ditch. The fraise is a good obstacle for works without flanking, as a redoubt, etc. The drawing shows the construction of the fraise, also the location of small pickets in the ditch. See *Accessory Means of Defense*.

FRAMEA.—A lance employed by the Franks. The entire head is of one piece, in which the end of the shaft is inserted and riveted.

FRAME-BRIDGE. — A bridge formed of timbers framed together in such a manner as to obtain the greatest possible amount of strength with a given quantity of material. The fundamental principle upon which all such construction is based is that the timbers shall be so arranged that the weight put upon them shall exert a pulling or a crushing strain, instead of a transverse strain, and, if possible, that the greatest strain shall act as a direct pull in the direction of the fibers of the wood. The construction of a frame-bridge is very similar to that of a roof, excepting that in the bridge a considerable outward thrust upon the abutments is generally permissible, while the walls of a house will not stand this; and that for the bridge a nearly level way on the top is desirable, while for a roof a steep incline is not objectionable, or is even desirable. The celebrated frame-bridge of Schaffhausen, constructed in 1757 by Grubenmann, a village carpenter, was built exactly in the manner of a roof, with the horizontal pathway superadded. It was composed of two arches, one 193 feet, the other 172 feet span. It was merely laid upon the piers, and did not abut against them to exert any outward thrust, as will be noticed in the drawing. The weight upon the bridge is transmitted



Bridge of Schaffhausen.

by the oblique beams, which by analogy we may call *rafters*, to the tie-beam *ab*, where it exerts a horizontal pulling strain. These rafters are framed into the tie-beam so as to abut firmly against it in the same manner as roof-rafters (see *Roof*). This kind of frame-bridge is very common in Switzerland, where timber-bridges abound; and it has doubtless originated from the fact that most of the bridges have been built by the local carpenters, who are accustomed to the construction of roofs of considerable span for the commodious square-built wooden cottages with overhanging roofs, so common in that country. Frame-bridges of more complex structure are sometimes built; in some of these the timbers are framed so as to present an arched form. In these cases the structure is very similar to those described and noticed under Centering. The serious defect of all such bridges is their liability to decay from exposure to moisture, etc., especially at the joints, where water is apt to lodge and remain, from want of free circulation of air to evaporate it. In the bridge of Schaffhausen above described, it was found that when it had stood but twenty-six years, the oak beams, where they rested upon the masonry at *a* and *b*, were rotted, and the frames began to settle. This was remedied by a carpenter named Spengler, who raised the whole structure upon piles by means of screw-jacks, and so replaced the decayed wood. Means should be adopted to admit the free circulation of air in those parts where the timber rests upon the masonry, and to prevent water from settling in the timber joints. The covered bridges of Lucerne and other parts of Switzerland are well known as objects of special interest to tourists, who usually imagine that the roofs are constructed for the comfort of travelers, but their main object is the preservation of the bridge.

FRANCHES.—Bodies of men detached and separated from the rest of the army, having each a Chief or a Commandant. They consisted chiefly of dragoons, hussars, etc., and their peculiar duty was to make irruptions into an enemy's country. They may not improperly be called Land-pirates, as their chief occupation was to harass and plunder the enemy and his adherents, in whatever manner they could, without paying any regard to military forms. The persons who composed these corps were termed partisans. They always accompanied the main army in time of war, and were distributed among the different garrisons in France during peace. They were common to every power in Europe. The Pandours and Hulans were of this description. They were the worst afflictions of war; and generally as fatal to their friends as to their enemies.

FRANCISQUE. — A battle-axe generally in use among the Franks. It was either used as a hatchet, or was hurled at the head or at the shield of the enemy. It was made under several varieties of form; and its blows if properly aimed took violent effect.

FRANC-TIREURS.—Bands of French soldiers that sprang into existence during the progress of the Franco-Prussian War (1870–1871). They did not form a part of the regular army, and at first their military organization was very imperfect; but this defect was afterwards in some measure remedied. They exercised a species of guerrilla warfare, attacking small detachments of the enemy, as also single travelers, baggage-trains, etc., their attacks being very often characterized by those savageries incident to this mode of warfare. They consisted mostly of the country population; but their birth, education, clothing, arms, age, and even their aim, were almost in every case different. At first they were not recognized by the Germans as having any military standing at all, and when seized they were shot; but after a time, when they received a better organization, and co-operated with the regular French army, such recognition was accorded them. The name was also applied to French soldiers, during the Crimean War, who were stationed as sharp-shooters, and to certain corps of light infantry in the republican wars.

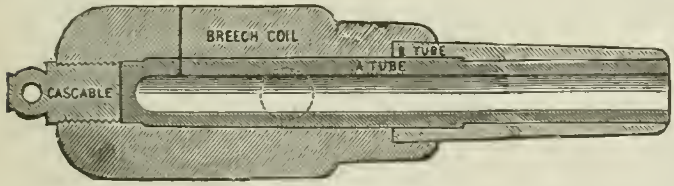
FRANKING LETTERS. — In the United States, established as a system before the adoption of the Federal Constitution, and continued with various modifications until the last day of June, 1873. At first granted only on letters of Revolutionary soldiers who were in actual service, its privilege was afterwards extended to the President, the Heads of Departments, the Chiefs of Bureaus, and certain Clerks designated by the Postmaster General. Public documents were also sent free. It was further extended to Senators and Congressmen for matter addressed by or to them, with certain limitations, before and after the sessions of Congress; Postmasters could *frank* official correspondence; newspapers were exchanged free, and petitions to Congress were sent free, but the weight of packages was limited to 4 ounces each. A further extension included the exchanges of the Smithsonian Institution, medals, and testimonials granted to soldiers. After July 1, 1873, the franking system was in part set aside, and an allowance of stamps was made to the various Departments to cover the expense of correspondence and of the transmission of reports and documents.

In England, on the introduction of the uniform penny-postage on all inland letters in 1840, the privilege formerly enjoyed by Peers and Members of the House of Commons, and many official persons, of *franking* was abolished. The privilege was claimed by the House of Commons in 1660, when the Post-office was first legally established, but it was afterwards dropped upon a private assurance from the Crown that it should be allowed to members. The Postmaster General accordingly constantly issued a warrant directing the allowance, till the privilege was expressly conferred by statute. In the days of *franking*, each Member of either House of Parliament was entitled to send ten letters every day, not exceeding an ounce in weight each, to any place in the United Kingdom, and to receive fifteen, free. As it was not necessary that the letter should be either written by or to the privileged person, the privilege was greatly abused; and most persons whose memories reach back to the period when it existed will remember family arrangements for taking advantage of it, by which the whole correspondence of the kindred, connections, and even the intimate acquaintances of a Peer, or a Member of Parliament, was in general carried on duty free. Up to the passing of the last-mentioned statute, all that was requisite was that the Member should write his name or title on the corner of the letter. From this time, however, till the abolition of the privilege, it was required that the whole address should be written by the Member; that he should add not only his name, but the name of the post-town, and the day of the month; and what was most troublesome of all, that the letter should be posted on the day on which it was written, or the following day, and in a post-town within twenty miles of which the person *franking* was then actually resident. By this regulation the kindly custom of giving franks to friends, or leaving them with them for future use, was rudely interfered with, and the public mind reconciled to the final abolition of what many regarded as a time-honored abuse. See *Official Envelopes*.

FRANKLIN MAGAZINE-GUN.—This gun belongs to that system in which a fixed chamber is closed by a bolt by direct action, and in which the lock is concealed. The receiver has a vertical slot cut entirely through it for the purpose of receiving cartridges from above and affording egress to the empty shells below. It has also a longitudinal slot through which the handle on the breech-bolt slides, with a side-cut at the front end of the slot for the reception of the handle when the bolt is locked. The breech-bolt is composed of three parts, viz., the locking-tube, the bolt-head, and the cocking-piece. To the latter of these the firing-pin, which extends the whole length of the breech-bolt, is secured by a screw. The bolt-head, which supports the cartridge at the instant of fire, is secured to the locking-tube by a pin at right angles to its axis. The firing-pin spring, which is held between the shoulder on the front of the firing-pin and that at the bottom of the locking-tube, serves by its tension to hold in contact the locking-tube and cocking-piece. By means of the spiral surfaces of a projection on the cocking-piece, and a corresponding recess on the locking-tube, the cocking-piece is cammed back, withdrawing the point of the firing-pin within the face of the bolt-head when the piece is unlocked. Accidental explosions are thus avoided in closing the bolt. The form of the cut in the receiver is such as to cam back the handle, and with it the bolt, during the unlocking, starting the empty shell. This is a necessary feature of all bolt guns which are intended to fire copper-case cartridges. The breech-bolt is prevented from being pulled completely out by the nose of the sear striking on the bolt-head. The magazine, which is a metallic tube, lies on top of the barrel. The magazine stop-spring is fastened at its rear to a lever, and its front is inclined to the axis of the receiver. When the handle is turned so as to unlock the breech bolt, a lever one extremity of which enters a groove, while the other is connected with the magazine stop-spring and its lever, is so moved as to cause the stop-spring to move forward, when its inclined front springs through an opening in the side of the receiver and partially covers the mouth of the magazine, preventing escape of cartridges. When the breech-bolt is returned to its locking position the stop-spring is returned to its first position by means of a spring operating its lever; at the same time the inclined face of the stop-spring bearing on the side of the cut in the receiver is pressed out of the way, and a cartridge issues from the magazine into the space above the breech-bolt. It follows, therefore, that a cartridge always occupies the space above the breech-bolt when the piece is locked, provided the magazine has been previously filled. When the bolt is withdrawn, this cartridge, under the influence of gravity alone, falls into a position in line with the axis of the bore. The bullet is supported by a shelf in rear of the chamber. The base of the cartridge is prevented from falling below the line of the axis of the bore by the shape of the slot in the receiver, which is only wide enough for the shell to fall through when its head is behind the extractor. This condition only obtains when the shell is being withdrawn. When the bolt is returned the cartridge is forced into the chamber and another one enters the space above the breech-bolt. A lid covers the opening at the top of the receiver. A catch serves to keep the lid closed except when the breech-bolt is unlocked. If the lid be raised during that time, a shoulder on its interior bearing against a lever prevents the stop-spring returning to its original position. The lid remaining open, the piece may be loaded and fired as a single-loader. No ejector is required with this gun, gravity again being called on to effect the fall of the empty shell through the opening to the ground. As a magazine-gun, three motions are necessary to operate it, viz., opened, closed, fired. As a single-loader, four motions are necessary, viz., opened, loaded, closed, fired. This gun carries ten cartridges in the magazine, one in the space above the breech-bolt, and one in the chamber. See *Magazine-gun*.

FRANKS.—The name assumed by a Confederation of German tribes that appeared on the Lower Rhine in the third century, and afterwards overthrew the Roman dominion in Gaul. It was only the name, however, that was new; the individual tribes composing the Confederation had been known on the Rhine as early as the time of Augustus. The most important of these were the Sigambri, Chamavi, Ampsivarii, Chatti, Chattuarii, and Bructeri of the time of the First Emperors. In the third and fourth centuries hordes of them began to pour through the Low Countries into Gaul, until at last the country became their prey. After the middle of the fourth century they appear divided into two groups, the Salians and the Ripuarians, the former inhabiting Holland and the Low Countries, the latter on both sides of the Rhine as far up as the Main. Each group had its own laws, afterwards committed to writing (*Lex Salica* and *Lex Ripuariorum*). Like the two peoples, these laws differ little even in detail.

FRASER GUN.—This gun is an important modification of the Armstrong gun, from which it differs principally in building up a gun of a few long double and triple coils, instead of several short ones, and a forged breech-piece. The Fraser 9-inch gun is represented in the drawing, where it is readily seen how a great expense is saved by this means of construction, as there is much less surface to be bored and turned. With respect to theory, it may be urged in its favor, in the first place, that a forged breech-piece (which is comparatively expensive, and liable to fly into fragments should the gun burst) is not required with a solid-ended steel barrel and long thick coils, although it is necessary with several short coils to compensate for the longitudinal weakness of their joints. The whole of the wrought-iron, therefore, can be coiled round the barrel, and thus give an extra transverse strength. Again, the trunnion-ring, which had to be shrunk on in the first construction, is welded on to the breech-coil in the Fraser plan, so that there is no fear of slipping. With regard to the second Armstrong principle, although a series of thin coils helps us to distribute the induced strain upon a gun by shrinking on each coil separately, the method is open to the serious objection that it is practically difficult to calculate the respective proportionate amount of extension, and, consequently, the greater the number of pieces in a gun, the more likely that some weakness will exist in the mass, owing to the undue strain on some of its parts. Shrinking on the coils successively was adopted by Sir William Armstrong, as a convenient mode of adhesion, and not on the distribution theory. In the formation of a triple coil, it is generally a manufacturing necessity to have the first coil cold before the second bar is wound round; but the third bar is wound on while the second coil is hot; the second and third layers, therefore, contract nearly simultaneously, and are kept in a state of tension by the first, which they compress to a certain degree, thus carrying out the theory of initial tension.



Fraser 9-inch Gun.

The barrel is made from a solid forged cylinder of cast-steel, drawn by heating and hammering; it is turned, bored, and chambered, then heated to a uniform temperature in a vertical furnace and plunged into a covered tank of rape-oil, where it cools and soaks. The muzzle-coil is constructed of two single coils, welded together endways. Each coil is formed by heating a long bar and wrapping it about a mandrel; this is next heated in a reverberatory furnace and welded under a steam-hammer Before being united, the two cylinders are turned and bored. The breech-coil is composed of a triple coil, a trunnion-ring, and a double coil welded together. The double coil is formed by placing a single coil, when cold, on a mandrel and winding over it, but in the reverse direction to break joints, a second bar; if over this a third bar is immediately wound in the same direction as the first, a triple coil will result. These coils are welded by being heated and hammered on end and on the sides. The trunnion-ring is made by welding slabs of iron together on the flat end of a bar, and gradually forming a ring by driving through the center wedges and mandrels increasing in size; the trunnions, one of which comes from the bar, are at the same time hammered into shape. The coils and the ring having been turned and bored, the latter is placed on a shoulder of the triple coil, the double coil is dropped through the trunnion-ring on to the triple coil, and the joints welded in this position. The cascabel is forged of good scrap-iron.

The different parts having been formed are accurately turned and bored with a slight taper. The B-tube, being heated, is dropped over the barrel, which is stood in a pit, a stream of cold water circulating through the bore. The half-formed gun is then placed on its muzzle, water forced through the bore, and the breech coil heated and slipped into position. The cascabel is screwed into the breech-coil abutting against the barrel, great care being taken that the contact is perfect. A tell-tale hole is cut along the thread on the cascabel to give warning by the escape of gas should the barrel break in firing. The vent is bored through hardened copper; it enters at near the center of the service-cartridge. This gives greater velocity, but also greater pressure. The large guns have from seven to ten grooves. The twist is uniformly increasing; the shape of the grooves is circular, with curved edges. Larger cannon are built up of a greater number of pieces. In some a coil (the belt) is placed between the muzzle and breech coils, with an additional coil (the waistcoat) under the breech-coil. Shoulders also are used, by which the parts when hot are hooked together. See *Armstrong Guns*, *Ordnance*, and *Woolwich Gun*.

FRAUD.—Any person in the military service of the United States who makes or causes to be made any claim against the United States, or any officer thereof, knowing such claim to be false or fraudulent; or who presents or causes to be presented to any person in the civil or military service thereof, for approval or payment, any claim against the United States, or any officer thereof, knowing such claim to be false or fraudulent; or who enters into any agreement or conspiracy to defraud the United States by obtaining, or aiding others to obtain, the allowance or payment of any false or fraudulent claim; or who, for the purpose of obtaining, or aiding others to obtain, the approval, allowance, or payment of any claim against the United States, or against any officer thereof, makes or uses, or procures or advises the making or use of, any writing, or other paper, knowing the same to contain any false or fraudulent statement; or who, for the purpose of obtaining, or aiding others to obtain, the approval, allowance, or payment of any claim against the United States or any officer thereof, makes, or procures or advises the making of, any oath to any fact or to any writing or other paper, knowing such oath to be false; or who, for the purpose of obtaining, or aiding others to obtain, the approval, allowance, or payment of any claim against the United States, or any officer thereof, forges or counterfeits, or procures or advises the forging or counterfeiting of, any signature upon any writing or other paper, or uses, or procures or advises the use of, any such signature, knowing the same to be forged or counterfeited; or who, having charge, possession, custody, or control of any money or other property of the United States, furnished or intended for the military service thereof, knowingly delivers, or causes to be delivered, to any person having authority to receive the same, any amount thereof less than that for which he receives a certificate or receipt, shall, on conviction thereof, be punished by fine or imprisonment, or by such other punishment as a Court-Martial may adjudge. And if any person, being guilty of any of the offenses aforesaid, while in the military service of the United States, receives his discharge, or is dismissed from the service, he shall continue to be liable to be arrested and held for trial and sentence by a Court-Martial, in the same manner and to the same extent as if he had not received such discharge nor been dismissed.

FRAYS.—All officers of what condition soever have power to part and quell all quarrels, frays, and disorders, though the persons concerned should belong to another regiment, troop, or company, and either to order officers in arrest, or non-commissioned officers or soldiers into confinement, until their proper superior officers shall be acquainted therewith; and whosoever shall refuse to obey such officer (though of an inferior rank, and of a different regiment, troop, or company), or shall draw his sword upon him, shall be punished at the discretion of a General Court-Martial.

FREEBOOTER.—A term commonly applied to one who wanders about for plunder; a robber; a pillager; a plunderer.

FREEDMEN'S BUREAU.—The branch of the War Department of the United States, established in 1865, to which was committed the supervision and management of abandoned lands, and the control of all subjects relating to refugees and freedmen from any district embraced within the territory covered by the operations of the army. It was managed by a Commissioner, with a number of Assistants. It was created to meet a special exigency: much of the work was long ago accomplished, and the principal functions of the Bureau ceased in 1870. During its existence the Bureau exercised a general supervision over the freedmen and other loyal refugees, protecting their rights, finding work and providing education for them, and furnishing medical treatment. More than 2100 day- and night-schools were in operation in 1869, with 2455 teachers and 114,552 pupils. The Bureau was instrumental in establishing institutions for the higher education of freedmen, such as Howard University at Washington, Atlanta University, Claflin University in South Carolina, and others. The number of rations issued to freedmen was over 15,000,000, and nearly 600,000 sick persons were cared for.

FREE-LANCES.—Roving companies of knights and men-at-arms, who, after the Crusades had ceased to give them employment, wandered from State to State, selling their services to any lord who was willing to purchase their aid in the perpetual feuds of the Middle Ages. They played their most prominent part in Italy, where they were known as Condottieri.

FREEMAN GUN.—A breech-loading rifle having a fixed chamber closed by a movable breech-block, rotating about a vertical axis at 90° to the axis of the barrel, and lying in the plane of the axis of the barrel. It is opened by cocking the piece and pulling back the horn of the breech-block; and is closed by pushing the horn forward with the right hand, a bevel on the left face of the breech-block pushing the cartridge home. When locked by the position of the breech-block it is also kept from turning by the front segment of the hammer engaging with a corresponding groove in the back of the block. It is fired by a center-lock of the usual pattern.

Extraction is accomplished by a bent lever pivoted below the chamber and struck by the ejector-cam, which, turning with the breech-block in opening the piece, rides over the curved horn of the extractor and draws back its upper end, carrying with it the cartridge-shell. Ejection is caused by a flat spring riding on a cam formed on the hub of the extractor, and thereby accelerating its action on the cartridge-shell when the latter has been started from its seat in the chamber in the act of opening the piece.

The arm has been modified so that the horn of the breech-block, instead of being solid with the block, is pivoted to it on a vertical axis, and has its lower portion cam-shaped, with a bearing on the side of the frame, so that a lever power is obtained in the first movement of opening the piece, when, if at all, the block is likely to stick. The hammer also has a projecting tooth on its forward surface, which engages with a notch in the under side of the firing-pin and retracts it when the hammer is cocked. The point of the firing-pin may thus be withdrawn from its impression in the cartridge-head, in order to allow the block to open freely.

FRENCH ARMY.—One of the chief Continental armies of Europe. Early in 1868 a Bill was carried through the French Chambers which raised the force of that country, nominally, to 800,000 men. The term of service was increased from seven to nine years. The rate of recruiting per annum was fixed at 100,000 men, selected by conscription; the proportion of which to the population (37,000,000) being about 1 to every 370. The nine years' service men were divided (as regards the 70,000 men who were called for service out of the 100,000) between five years passed under the Regimental Colors and four years in a General Reserve, called the Second Reserve. The remaining 30,000 men were enrolled in the First Reserve, and were not required to perform any military service in peace-time, except five months' drill in each of the five years. Those who were not drawn by conscription had to serve five years in the *Garde Mobile*, being called upon to take the field on emergency. Such was the military system of France when the war of 1870–71 broke out. It proved inefficient to produce a trained Second Reserve; and in order to insure the French army an ample and constant supply of recruits, the law of general military service of the First Republic was restored in its fullest vigor, in a Bill passed by the French Assembly in July, 1872. The present system alters entirely the military recruiting of that country, and is similar to the German one, as will be seen by the following principal clauses: Every Frenchman is liable to military service, and must serve personally, the system of substitute being abolished. He is called upon to serve from the age of 20 (instead of

21, as by the former law) to the age of 40, the period of service being thus distributed: five years in the Active Army; four years in the Reserve of the Active Army; five years in the Territorial Army; six years in the Reserves of the Territorial Army. Every man enrolled in each yearly contingent has to serve for twelve months at least, except those for the service of special arms—artillery, engineers, and cavalry, which require a longer training—and they have therefore to serve a much longer time. Notwithstanding all permanent exemption being abolished, there are certain strictly determined cases of a temporary kind which exempt men from the service, such as supporters of families, eldest brother of orphans, only son or grandson of widows, etc. Young men who have obtained university and college degrees, and those who belong to government schools, and who desire to continue their studies, may volunteer for one year. They are called *Volontaires d'un an*. The men of this class must defray at their own expense the cost of their uniform, equipment, and horse, if in the cavalry. After one year they have to pass an examination, and, if not successful, have to remain another year in the ranks. At the end of their term, they receive, as a rule, certificates of qualification as Non-commissioned Officers or Officers in the Territorial Army. Like all others, they are liable to be called upon to serve on the outbreak of war. The rate of recruiting by this new law is computed to give France a yearly contingent of 150,000 men, deductions being made on account of the "dispensed with" class. Each contingent is therefore, in different ways, subject to serve for twenty years, and consequently at the end of that period the forces of France will amount to an aggregate of twenty contingents of 130,000 each, with deductions for deaths and casualties, giving a total of 2,423,164 men. In addition to these levies, France has a Permanent Army of 81,722 men, belonging to the permanent effective, not recruited by means of the conscription, composed of Officers, Staff, Administrative Corps, *Gendarmerie*, etc. The active army in time of peace has (1875) a strength of 480,000 men, and in time of war, by calling in the trained contingents of 780,000 men, organized in corps, and ready to take the field at once on the outbreak of a war, has behind it "Troops of Reinforcement" amounting to 279,000 men, who have all served at least one year in the army. These Troops of Reinforcement will be distributed in the corps depots, together with the 150,000 men of the last class called up and not yet fully instructed. Thus the fighting army of 780,000 men may be increased by 429,000 men ready to fill up vacancies in the fighting corps.

The organization of these forces was the subject of the Bill passed by the Assembly, and promulgated in March, 1875; it is known as the *Loi des Cadres*. By this law, France is divided into 18 military regions, each garrisoned by an Army Corps, besides a special Corps (19th) for Algeria. Each Army Corps has 2 infantry divisions, 1 brigade of cavalry, 1 brigade of artillery, 1 battalion of engineers, and 1 squadron of field-train, besides staff and auxiliary services. The several Army Corps are recruited indifferently from the whole contingent, and during peace may be moved from region to region; but the Reserves are organized in their own regions. On the outbreak of war, the men of the Reserve will be mobilized near their homes, clothed and armed at depots already known to them, within a day's walk, and sent to swell the ranks of that Corps which happens to be stationed in the region at the time. The Territorial Army will, at all times, belong to its own region. Its duties in war will be to garrison fortresses, defend strategic points, work the lines of communication, and set the active army free for field-operations, but, when urgent, will also co-operate in the field with it. The French army is composed as follows: 144 regiments of the line, each regiment consisting of 4 battalions, and each battalion of 4 companies, with 2 depot companies; 30 battalions of foot-chasseurs (*chasseurs à pied*), each battalion of 4 fighting companies and 1 depot company. In addition, the 19th *Corps d'armée*, quartered in Algeria, comprises four regiments of *zouaves*, each regiment of 4 battalions, consisting of 4 fighting companies and 1 depot company; three regiments of Algerian sharp-shooters (*turcos*), organized like the *zouaves;* one foreign regiment of 4 battalions, each 4 companies strong; five discipline companies (*zéphyrs*). Each fighting company consists of 1 Captain, 1 Lieutenant and 1 Sub-lieutenant, 1 Sergeant Major, 4 Sergeants, 1 Quartermaster Sergeant, 8 Corporals, 2 drummers or buglers, and 66 privates; total per company on peace-footing, 3 officers and 85 rank and file. At 16 companies per regiment, this gives an aggregate of 48 officers and 1312 rank and file. The two depot companies present an effective of 6 Officers, 32 Non-commissioned Officers, and the number of men remains unknown. On the war-footing, each company is increased by 1 Lieutenant or Sub-lieutenant, 1 Quartermaster Corporal, 4 Sergeants, 8 Corporals, and 2 drummers. The cavalry branch of the service consists of 77 regiments, viz.: 12 regiments of cuirassiers, 26 regiments of dragoons, 20 of *chasseurs*, 12 of hussars, 4 of *chasseurs d'Afrique*, and 3 regiments of *spahis* (native cavalry of Algeria). The 70 home regiments form 18 brigades of 2 regiments each, one of which is attached to each *Corps d'armée*. This leaves 34 regiments available to form independent cavalry brigades and divisions. Each of the 70 home regiments consists of 5 squadrons, having on peace-footing 45 officers, 830 men, and 740 horses. The African regiments are 6 squadrons strong, and their effective amounts to 59 officers, 978 men, and 930 horses. In addition there will be 19 squadrons of cavalry volunteers, who will supply the Generals and Staff Officers with men capable, from previous instruction, of performing, efficiently, duties as guides, escort, orderlies, etc. The artillery consists of 38 regiments quartered in France, forming 19 brigades, 2 per Army Corps. The first regiment of each brigade consists of 3 batteries *à pied* (without guns), 8 batteries *montées* (with guns), 2 *montées* depot batteries (provided with guns for drill and practice purposes); in all 65 Officers, 1349 Non-commissioned Officers and men, and 635 horses. The second regiment of each brigade consists of 8 mounted batteries, 3 batteries of horse-artillery, and 2 mounted depot batteries; 68 officers, 1369 men, and 878 horses. There are 2 regiments exclusively intrusted with the Bridge and Ponton Department, 10 companies of Artillery Artisans, 3 Rocket Companies, and 57 companies of the Artillery Train. The Engineering Department consists of 4 regiments of sappers and miners, and that of the Military Train of 20 squadrons.

Besides the above forces, there are certain auxiliaries, viz.: Military Clerks and Artisans; Ambulance Staff and Attendants (*infirmiers militaires*); Military Chaplains; the *Gendarmerie* and a regiment of Firemen of the City of Paris, who are picked men from the army; a Corps of Military Interpreters, a Telegraphic Staff and Corps, a Railway Staff and Corps, the three latter being borrowed from the German system. The various railway lines in the rear of the army are to be worked by these Corps, under military superintendence in front of the lines. To secure a competent military Railway Staff, a certain number of sappers and miners, after one year's service with the Colors, will be told off to the various railways to complete their professional instruction.

The French army is officered partly from the ranks, partly from the Military Colleges, specially from the latter. Major Brackenbury, in the preface to his translation of the law on the general organization of the French army, adverts to the subject of the principles on which it has been remodeled, as follows: 1st. General obligation to military service. 2d. A peace organization approaching as nearly as possible the organization for war. The Corps are always ready with their Staffs and administrative services, and only require the addition of their Reserves—always close at hand—in order to go into the field. Their stores are also on the spot. 3d. Decentralization. Each General mobilizes his own Corps, is responsible for his own first supplies, and can have no one but himself to blame if he is slow or wants anything. 4th. On the other hand, the Government has a Corps of Inspectors, who will during peace detect the incompetence of a Commander. 5th. The Control is carefully separated from the Administration, and the Generals are expected to be good administrators as well as good leaders of troops. 6th. Recruiting, remounts, hospitals, etc., are managed by the Territorial Staff in each region, but always under the General Commanding the Corps then present. When a Corps is mobilized and quits its region, the command of the region and its territorial troops is handed over to an officer previously appointed by the Minister. In order to act up to the spirit of the new law, the War Office has been reconstituted under conditions more in accordance with the organization of the army; and the Department of the Chief of the General Ministerial Staff comprises now a Ministerial Cabinet and five Bureaux, namely: First Bureau—general organization and mobilization of the army; positions and strength; general correspondence; Second Bureau—military statistics; historical office; Third Bureau—military operations; instruction of the army; topographical office; Fourth Bureau—*Etappen* and railway service; execution of movements of troops; transport of troops by land and sea; Fifth Bureau (or war depot)—technical services; collections; material and accounts of the General Staff. Two Deputy Chiefs of the Staff are attached to the Chief of the Staff.

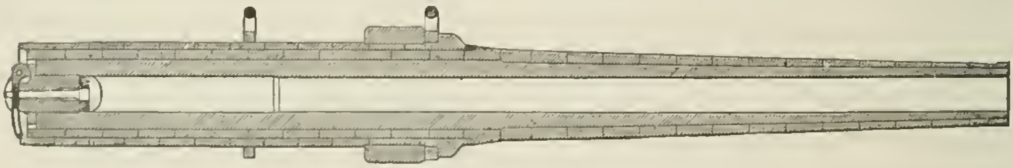
FRENCH ARMY ORDNANCE.—The broad features of construction of the army heavy ordnance are essentially those finding place in the naval guns, but the power deemed necessary for land purposes is much more limited, of course, than for marine and sea-coast uses; and hence we find that a 24^{cm} gun is the highest type introduced into this branch of the service. The steel guns are known as the Modèle de Bange. The body of the gun is composed of a tube of cast-vice of France. There are no novelties to point out in this construction other than those stated. The charges are 84 lbs. of powder and 336 lbs. weight of projectile for the 24^{cm} steel; and 62 lbs. and 265 lbs. for the 24^{cm} cast-iron and steel constructions. The former gives (it is reported from official sources) a velocity of 1598 feet, and a resulting muzzle-energy of 6000 foot-tons.

The Modèle de Bange, 24^{cm}, it will be seen on an inspection of the accompanying drawing, is a well-proportioned gun of extreme simplicity in design; the only part of any moment in a constructive point of view being the body. The weight of the entire gun is only 13.75 tons. The frettes, trunnion-bands, and other parts outside of the core weigh 7 tons. All these parts are small in size, hence readily handled, the rough-turned steel forgings from steel-works are readily obtained, the only prominent part being the body. The assembling and finishing of the gun is simple work, and within the capacity of ordinary machinery and appliances. The only question is if it has sufficient longitudinal (breech) strength. However this may be, it is a construction well worthy of consideration.

The following table gives the charges, etc., of the more important guns of the French service, and also shows their relative energies per ton of metal:

Caliber	Charge	Projectile.	Initial velocity.	Muzzle-energy.	Energy per ton of metal.	Kind.
	Lbs.	*Lbs.*	*Feet.*	*Ft-tons*		
42^{cm}....	617.3	1,726	1,738	36,628	485.8	Navy.
37^{cm}....	545.6	1,177	1,955	31,180	415.7	Navy.
34^{cm}....	462	924	1,955	24,482	415	Navy.
27^{cm}....	237.6	464	1,955	12,294	396.6	Navy.
31^{cm}....	440	935	1,950	24,647	493	Schultz.
24^{cm}....	84	336	1,600	6,033	430	Army steel.

It will be seen that the views of the French engineers on construction are about the same as those now existing amongst English constructors, and that

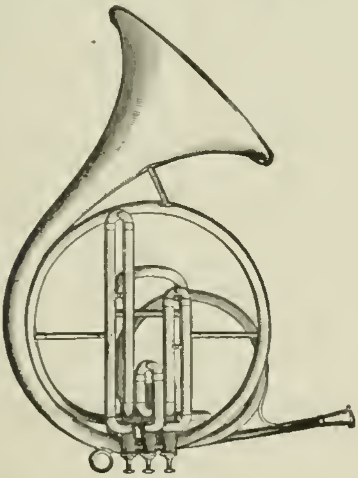


Modèle de Bange, 24^{cm}.

steel (tempered in oil and annealed), reinforced by frettes of puddled steel (tempered in oil or water). The breech-frette is prolonged in rear of the base of the tube, forming a protection for the breech-mechanism. The trunnions, except in field-guns, are hollow. Pieces of a heavy caliber have carrying-handles. The frette first placed in position abuts against a shoulder on the tube, which prevents any forward sliding. (In the 180^{mm} and 240^{mm} guns, fretted all the way to the muzzle, it is the last cylindrical frette.) The extremity of the chase is strengthened by a swell of the muzzle shaped like a band. The seat of the breech-mechanism has nearly the same diameter as the bore. The threads of small dimensions have a very short pitch. Their section is a rectangular isosceles triangle, the top of which is flattened. The cylindrical powder-chamber, with a diameter nearly the same as that of the bore, is connected with the latter by a truncated surface of short length where the grooves commence and against which the projectile abuts when seated home. The ordinary screw fermeture, but with the De Bange gas-check, is used. The 24^{cm} gun, model 1876, is a cast-iron gun similar in construction to the model of 1870 for the body of the gun, the fermeture differing, however, in the substituting of the De Bange gas-check, which is universally used in the land-ser-they are striving to reach results in power combined with lightness which are gradually rendering *imperative* the ultimate discarding *in toto* of cast-iron in their models. A brief summary may here be added in closing this notice of French heavy ordnance. 1. A long and patient test of, and an experience (in breech-loading systems) with, steel-fretted cast-iron has resulted in failure and abandonment. 2. The adoption of the model of 1870, cast-iron hooped and tubed, has given good results, warranting the introduction of this type in service. 3. That with the development of the steel interests of France, the French Authorities are not satisfied with cast-iron entering into their constructions, and are resorting to steel entirely, and that they contemplate the disuse of the former. 4. That wire guns are being persistently experimented with, and are looked to as promising to be introduced as the guns of the future. 5. That constructions looking to the "division of strains" are regarded as the probable solutions of the dangers arising from the combination at the breech of the longitudinal (breech) and tangential (breech) stresses; and that the Schultz plan is preferred. 6. That a new, simple, and an apparently effective fermeture, other than the Broadwell, has been tested with success, approved and adopted at least in the land service of France. This fermeture is known as the De Bange. 7. The undoubted tendency in France, in England, and in other countries is to resort to steel constructions for ordnance. This leaves us to remark that the use of this metal in some form or other—as developments in production in our country may decide—is a foregone conclusion; and that some plan looking to its speedy, *practical* introduction in our fabrications cannot too soon be inaugurated. See *Ordnance.*

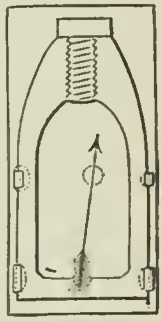
FRENCH FRICTION-TUBE.—The French primer, of which ours is a modified and improved form, was adopted in the French army in 1847. The large tube with a cross-head at the top to prevent its entering the vent too far, is stopped at the top by a wooden plug held in place by an indented girdle. Below this and inside the large tube is a smaller tube, the upper part of which is filled with a fulminating powder composed of $\frac{1}{3}$ chlorate of potassa and $\frac{2}{3}$ sulphuret of antimony mixed with gummed water or alcohol. This is pierced through the axis to give passage to the friction-wire, the lower end of which is flattened and serrated. This serrated part remains in the empty part of the small tube, the lower end being clinched around the end of the tube. The small tube being prepared with the fulminate, the wire is introduced into the large tube, passing out through the hole in the axis of the wooden plug. The wire is then twisted on itself and bent down along the tube. The primer is then finished by filling the lower ends of both tubes with musket-powder, and closing the end of the large tube with a mixture of wax and pitch. The opening around the wire where it passes through the wooden plug is closed with a drop of wax.

FRENCH HORN.—A wind-instrument, commonly called in the United States *horn;* in Italy, *corno;* in France, *cor de chasse.* Its form is that of a lengthy tube of brass, with a large bell-shaped ending. For greater convenience the tube is coiled up into continuous circles, lying side by side, the coils being soldered together, to keep them in their position.


French Horn.

It is sounded by means of a mouth-piece, in form like a little hollow cup. The thinner the sheet-brass is of which the horn is made, the more easily can the sound be produced. The sounds obtained on the French horn are the harmonics of the sound of its whole length, a fundamental sound which cannot be produced by the mouth. As those sounds form only a limited scale, the notes wanting are artificially made, by the hand being inserted into the bell, so as to flatten a higher note down to a lower one. These flattened notes are called stuffed notes, as the sound of them is muffled. The French horn in its natural state can only be played in one key; but by means of crooks, which are added to increase the length of the tube, it can be transposed into any key. When at its greatest length it measures, from the mouth-piece to the end of the bell, 16 feet. The music for the French horn is always written in the key of C, with the key of the composition marked at the beginning of each movement; thus, corno in D, etc., guides the performer as to the crooks he must use in order to play the notes in the key indicated. The stuffed notes on the French horn being very defective in quality of sound, in comparison with the great beauty of the open notes, many inventions have been from time to time tried to remedy them, the most successful of which is the valve-horn, which is constructed so that the performer can, by means of three valves, lengthen or shorten the tube so as to produce any note in the chromatic scale, as a harmonic of the length of the tube, and consequently all the notes are of the same quality of sound, and open notes. The valve-horn is now generally used as a solo instrument with greater effect than the common French horn. As a band and orchestral instrument the French horn is of great importance. There are never less than two French horns in an instrumental score, and in many great works four are absolutely necessary. The date of its invention is lost in antiquity. See *Band.*

FRENCH PROJECTILE.—The projectile used in the French field-service is made of cast-iron, and has twelve zinc studs on its sides, arranged in pairs, so as to fit the six grooves of the gun. For the larger cannon-projectiles but three studs are used, and these are cast on the projectile, nearly opposite to its center of gravity; the bearing sides of the studs are faced with white metal to diminish friction against the grooves of the bore. The shape of the grooves is such as to center the projectile. The latter projectile is used with increasing, the former with grooves of uniform, twist. Russian, Austrian, and Spanish artillery-projectiles belong to this studded or button class, but differ from each other in the details of their construction. See *Compression-projectiles* and *Projectiles.*



FRENCH SIGHTS.—In this system, employed when the target is invisible, specially constructed sights (used in the ordinary sight-slots) are provided, having cross-bars on their heads, divided into scales of equal parts, and parallel to the axis of the trunnions.

The whole of the rear bar can slide laterally through the head of the rear sight, and there is a scale of degrees and minutes on the cross-bar which registers the amount of sliding or "deflection." The other bar is a fixture. Each bar carries a sliding sight-leaf.

If the target can be seen at any time from the battery, the piece is laid in the ordinary way, both sliders being clamped at the same graduation near the middle of each bar. A plumb-line and a vertical chalk-line drawn on a board (or, in confined positions, two plummets hanging from frames in the rear) are aligned on the sights, should firing through smoke or by night be afterwards expected. These sights are chiefly employed with the siege-artillery. See *Sight.*

FRET.—A figure, used in Heraldry, resembling two sticks laid saltierwise, and interlaced with a mascle. When six, eight, or more pieces are represented crossing and interlacing like lattice-work, the shield is said to be *fretty.* See *Heraldry.*

FRETTAGE.—The introduction and development of hooping cast-iron with steel bands in strengthening the former material in gun-construction have been noted with much interest. It appears that the first attempt was made in 1836, at the foundries of Liege, in Belgium, where the minor powers of Europe, and even Russia, procured their cannon at that time; resort being had, however, also to the well-known Swedish foundries of Fingspong and Aker. The method was first brought into notice at Ruelle, in 1843. It was introduced a few years later by Blakely in England; and in 1859 it was tested again in France, at Vincennes, by the Navy Department, and officially adopted for all its rifled guns. In 1864, in the model then adopted, the exact allowances for shrinkage were established, based upon both practical and theoretical observations. The allowance for shrinkage, it is intended, shall be such as to secure a compression of the interior strata according to the theories of Gadolin and Lamés. The amount of diminution of diameter of tubes varies from .003 to .007 inch. It is hardly necessary to allude to the fact that the large constructions for naval service have two series of puddled steel frettes, made at Le Creusot and Rive de Gier. The banded portion of the cast-iron body is, according to general rules, about one caliber in thickness, and the bands .25 caliber for each row, giving a thickness at the seat of dangerous pressures of about one and one half calibers. The operation of shrinking on the hoops requires but simple and ordinary appliances. An oven, modeled after the ones employed in England for heating tires for wheels, supplies the means for heating up the frettes to the proper temperatures. They are transferred from thence by means of a small crane, and are placed in their proper positions on the exterior of the prepared cannon-body by two or three workmen. A circular tube and collar containing water, which escapes in jets on to the superimposed frette, supplies the means for cooling. It is applied not directly after the placing of the frette in position, but in about ten minutes after the latter operation has been completed. After preparing the body, and the assemblage of the first row of bands, the gun is transferred to the boring-lathe, and the exterior of the frettes accurately turned, and the preparations for the application of the second row of bands completed. After this row has been superimposed the gun is sent to the machine-shop for the final process of fitting the fermeture, rifling, and other necessary work to complete the manufacture. Proof-frettes are tested for elasticity, and proof of endurance by a shrinkage test. A cast-iron cylinder is used over which the experimental hoops are placed under a definite tension by heat, and when the parts are cut the cylinders are broken up and the frettes under proof measured and otherwise examined. A shrinkage determined upon, say, nearly up to .002 of the diameter, and a slightly less one for trunnion-bands, should attain without any permanent set resulting in enlargement. They should withstand an enlargement not exceeding .004 without rupture, or development of serious superficial defects sufficient to warrant rejection. Based upon these trials, the frettes are prepared which are to be used in construction. In the application of frettes or trunnion-bands to the bodies of guns the establishment of the limits of shrinkage must largely depend upon the results of the testing-machine for physical properties, and limits which may be determined by one set of experiments may be non-concurred in by another, operating on different metals used in different countries. The data resulting from French experiments are, therefore, matters of interest, but furnish no definite standard for following absolutely when other steels are used. See *Tubage*.

FREYTAG SYSTEM OF FORTIFICATION.—In this system the maximum of the angles of bastions is fixed at 90°. The flanks are perpendicular to the curtain, and the whole enceinte is surrounded by a fausse-braye on a level with the ground. The salients of bastions are covered by lunettes, and the curtains by ravelins. The escarps have no revetment. The chief defense of this fortification rests on the wet ditches; which, however, fail in frosty weather. The ravelins are too small to cover even the curtain, and the lunettes, when taken, afford a very advantageous lodgment for the enemy.

FRICTION.—When one body rubs against another as it moves, a certain force is felt to resist the motion. This resistance is called *friction*. As a considerable proportion of the motive power in all operations is spent in overcoming the friction of the parts of the machine upon one another, and is thus lost for the useful work, it is of great importance to understand the nature of this obstructive force, with a view to reduce it to the least possible amount. Accordingly, a great many careful experiments have been made on this subject, and the result is a number of precise and valuable facts or laws regarding friction which are now considered certain and reliable. The more important may be thus stated and illustrated. When a block of oak—say a cubic foot, which weighs about 60 lbs.—is placed on a horizontal table of cast-iron, the two surfaces being flat and smooth, it requires a force of nearly $\frac{2}{5}$ the weight of the block, or 24 lbs., pulling horizontally, to make it slide along the table. This measures the friction between the two surfaces. Another block of the same size and shape laid on the same table would require the same force to draw it; and if the two were laid side by side, and fastened together so as to become one block, it would evidently require double the force, or 48 lbs., to draw the double block; the amount of the friction being thus still $\frac{2}{5}$ of the weight, or of the pressure between the two surfaces. But suppose that, instead of being laid side by side, the second block were laid on the top of the first, what is to be expected? Here the weight is doubled as before, but the extent of rubbing surface remains unaltered; it would be natural, therefore, to expect that this would make a difference, and that, though the friction would, of course, be increased, the increase would be less than in the former case. Experiment, however, shows that there is no difference, and that the friction is exactly double in both cases. In short, the unexpected and important fact is established that, *within certain limits, the friction of any two surfaces increases in proportion to the force with which they are pressed together, and is wholly independent of the extent of the surfaces in contact.* The amount of friction between two bodies is thus a constant fraction or proportion of the force with which they are pressed against each other. This fraction differs for the different kinds of surfaces. Thus, between oak and cast-iron it is, as already stated, about $\frac{2}{5}$, or more exactly, .38; for wrought-iron on wrought-iron (we speak at present of dry surfaces, without grease or unguent of any kind) it is .44; for brass upon cast iron, .22. This constant fraction (expressing the proportion between the pressure of two surfaces and their friction) is called the *coefficient of friction* for these two surfaces. Friction is very much diminished by the use of grease or unguents. The coefficient of wrought-iron upon oak, which, in the dry state, is .49, is reduced by the application of water to .26, and by dry soap to .21. The result of experiments on this subject is stated to be "that with the unguents hog's lard and olive-oil interposed in a continuous stratum between them, surfaces of wood on metal, wood on wood, metal on wood, and metal on metal (when in motion), have all of them very nearly the same coefficient of friction, the value of that coefficient being in all cases included between .07 and .08." Tallow gives the same coefficient as the other unguents, except in the case of metals upon metals, in which the coefficient rises to .10. In the case of wood on wood, black-lead is frequently employed for the same purpose. The most important fact, perhaps, and one that could hardly have been anticipated before experiment, is *that the friction of motion is wholly independent of the velocity of the motion.* The resistance to the motion of a wheeled carriage proceeds from two sources—the friction of the axle, and the inequalities of the road. The resistance of friction to the turning of a shaft in its bearings, or of an axle in its box, has evidently the greater leverage the thicker the journal or the axle is; the axles of wheels are accordingly made as small as is consistent with the required strength. The resistance that occurs between the circumference of the wheel and the road constitutes what is called *rolling* friction. There are on all roads, to a greater or less extent, visible rigid prominences, such as small stones, in passing over which the wheel and the load resting on it have to be lifted up against gravity. But even if these were wanting, the hardest road yields, and allows the wheel to sink to a certain depth below its surface; so that in front of the wheel there is always an eminence or obstacle, which it is at every instant surmounting and crushing down. This is the case even on iron rails, though of course to a much less extent than on any other road. Now, for overcoming this resistance, it can be shown, on the principle of the lever, that a large wheel has the advantage over a small one; and by numerous experiments the fact has been fully established that over horizontal roads of a uniform quality and material *the traction varies directly as the load, and inversely as the radius of the wheel.* The best direction of traction in a two-wheeled carriage is not parallel to the road, but at a slight inclination upward, in proportion to the depth to which the wheel sinks in the road. On a perfectly good and level macadamized road the traction of a cart is found to be $\frac{1}{30}$ of the load; that is, to draw a ton, the horse requires to pull with a force equal to 75 lbs. On a railway the traction is reduced to $\frac{1}{280}$ of the load, or to 8 lbs. per ton. While friction thus acts as an obstruction to motion, and wastes a portion of the motive power, it has also important uses. It is, in fact, an indispensable condition, no less than gravity, in the stability of every structure, and in every mechanical motion on the earth's surface. How essential it is to our own movements we experience when we try to walk on ice! Even on ice there is still considerable friction, so that one foot can be slightly advanced before the other; were it altogether annihilated, we could not stir a fraction of an inch, even supposing we could stand upright. Without friction, a ladder could not be planted against a wall, unless there were a hole in the ground to retain the foot. In short, no oblique pressure of any kind could be sustained. The advantage of railways consists chiefly in the diminution of friction; but were this diminution carried much further, there could be no motion whatever, at least by means of locomotives. Without a considerable friction, the driving-wheels of the locomotives would slide round on the rails without advancing; and this sometimes happens when particular states of the weather render the rails as if they were greased. The force of friction is often directly employed in mechanics. It is used, for instance, to communicate motion by means of belts, chains, etc. It is the force that holds a knot. It is specially useful when a machine, with great momentum, has to be checked or arrested in its motion. The best example of this is the *brake* used on railways. By means of a system of levers, blocks of wood are made to press upon the circumferences of a number of the carriage-wheels; and thus the momentum of a train weighing hundreds of tons, and moving with a velocity of perhaps 50 miles an hour, is gradually destroyed in a wonderfully short space of time. *Friction-wheels* are employed to diminish the friction of axles on their supports. Two wheels, of a large circumference in proportion to their weight, are located close together, parallel to each other, and so that the one seems to overlap the half of the other; in the notch thus formed by the upper circumferences of the wheels one end of the axle rests; a similar arrangement being made for the other end. The friction, which formerly acted directly on the axle, is by this arrangement referred to the axles of the friction-wheels, and is, by the laws of mechanics, reduced in the ratio of the circumference of the friction-wheel to the circumference of its axle. In order to render the friction of the friction-wheels themselves the least possible, they are made as light and as large as is practicable.

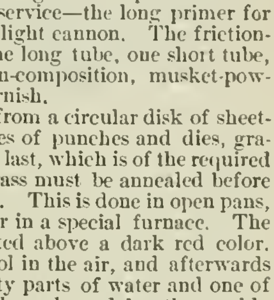
FRICTION-CHOCKS.—Brakes attached to the common standing garrison-carriages of guns, so as to raise the trucks or wheels off the platform when the gun begins to recoil, to prevent its running back.

FRICTION CONES.—A kind of coupling in which motion is communicated by the friction of the surface of a cone fixed on one shaft against the inner surface of a similar cone, into which it may be thrust, fixed on another shaft. The friction-cone prevents the elevating gear from breaking on firing, by enabling the gun to twist the cone round inside the *worm-wheel,* when it gives a severe blow.

FRICTION-PLATE.—A plate of iron placed on the side of the trail-beam of wooden gun-carriages at that point where the wheel locks with the carriage. The plate is placed in that position to prevent injury to the trail when the limber is being turned at an angle to the gun-carriage. Friction-plates are also used to check the recoil of guns. See *Elswick Compressor* and *Recoil.*

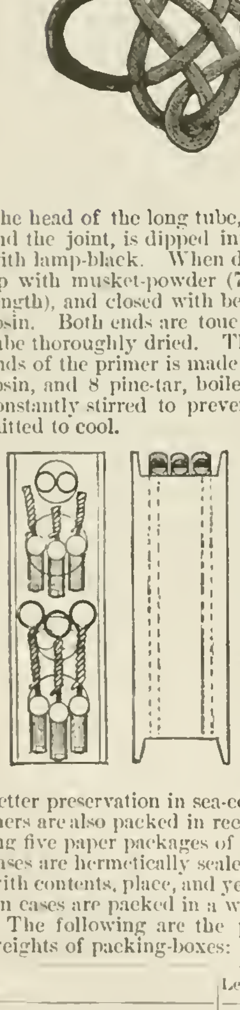
FRICTION-PRIMERS.—The friction-primer for cannon is a small tube of brass filled with gunpowder, which is ignited by drawing a flat wire with serrated edges briskly through friction-composition contained in a smaller tube inserted into the first near the top and soldered at right angles to it. A lanyard, with a hook attached, is used to ignite the primer. Two kinds are in use in the service—the long primer for heavy, and the short for light cannon. The friction-primer is composed of one long tube, one short tube, one wire igniter, friction-composition, musket-powder, wax, and shellac varnish.

The *long tube* is made from a circular disk of sheet-brass by means of a series of punches and dies, gradually diminishing to the last, which is of the required size of the tube. The brass must be annealed before each drawing or reducing. This is done in open pans, or in a revolving cylinder in a special furnace. The brass should not be heated above a dark red color. It is then allowed to cool in the air, and afterwards pickled in a bath of forty parts of water and one of sulphuric acid to remove the scale, and then thoroughly washed to remove all trace of acid. Thickness of sheet-brass disk, .036 inch; diameter, .62 inch for short, and .98 inch for long primers. The tube is cut to the prescribed length, measuring from the closed end, by means of a circular saw, and the holes for the short tube and wire igniter are drilled and the burs removed. Length of long tube for short primer, 1.75 inch; for long primer, 2.35 inches; exterior diameter, maximum, .195 inch; minimum, .187 inch; interior diameter for short primer, .175 inch; and for long primer, .155 inch; diameter of holes, .15 inch and .06 inch.



The *short tube* is derived from the longer one by using two additional punches and dies, reducing the size each time. It is made to the proper length by circular saws placed at the required distance apart, and the bur is removed by rolling in a barrel. Length of the shorter tube, .44 inch; exterior diameter, .15 inch; interior diameter, .133 inch. One end of the short tube is dipped in a solution of zinc chloride, inserted in the hole drilled in the long tube, heated in the flame of a spirit-lamp, until solder melts, and soldered with soft solder; it is then washed and dried. The *wire igniter* is made of brass wire .05 inch diameter, annealed, cut to the proper length, and pressed flat at one end by a machine for that purpose. The flat end is serrated by a punch and die with dentated edges, and the tip is annealed in the flame of a spirit-lamp. Length of wire, 3.4 inches; length of flattened end, .65 inch. The *friction-composition* is made of 55 parts antimony trisulphide, 37 parts potassium chlorate, 5 parts flowers of sulphur, and 3 parts gum arabic. The materials must be finely pulverized, and mixed thoroughly in a bowl of stone-ware by stirring with equal quantities of alcohol and water until the mixture attains the consistency of paste.

The small tube is charged by pressing the open end in the friction-composition spread on a flat piece of zinc, and brought to the consistency of soft putty, the long tube being closed its whole length with a wooden or metal plug. A conical hole is made in the composition while yet moist, with a conical drift, and the surplus composition removed; the wire igniter is passed through the short tube and through the small hole in the long tube, the round end first, leaving the annealed tip projecting out of the open end, which is then closed by pressing the top and bottom together firmly with pincers, and bending the tip against the bottom. The end of the wire igniter is doubled on itself and twisted, leaving a loop .2 inch diameter. The head of the long tube, including the short tube and the joint, is dipped into shellac varnish colored with lamp-black. When dry, the long tube is filled up with musket-powder (7 or 10 grains according to length), and closed with beeswax mixed with tar and rosin. Both ends are touched with varnish, and the tube thoroughly dried. The material for closing the ends of the primer is made of 15 parts of beeswax, 5 rosin, and 8 pine-tar, boiled 2½ hours on a slow fire, constantly stirred to prevent burning, and then permitted to cool.



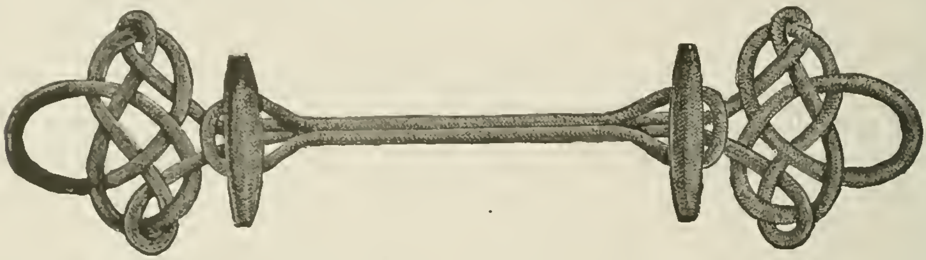
To pack the primers, rectangular wooden blocks are made, having holes .38 inch and .57 inch in diameter, bored in two opposite ends. The primers are placed in the holes, 5 or 10 to each block. The block is covered with a paper wrapper, which is then varnished. A printed label tells contents, place, and year of manufacture. The blocks are packed in wooden boxes containing 1000 of five primers each, or 100 of ten each. For better preservation in sea-coast fortifications, the primers are also packed in rectangular tin cases, containing five paper packages of 20 primers each. The tin cases are hermetically sealed, japanned, and stenciled with contents, place, and year of manufacture. Fifty tin cases are packed in a wooden box.

The following are the principal dimensions and weights of packing-boxes:

	Length	Width.	Depth.	Weight
	Inches.	*Inches.*	*Inches.*	*Pounds*
Cases for short primers....	7.35	2.2	2.1	1
Cases for long primers. ...	7.6	2.65	2.2	1.56
Box for 1000 blocks	22	12	12 5	83
Box for 100 blocks { Long primers.	16	9	6.125	26
Box for 100 blocks { Short primers.	12	9	6 125	22
Box for 50 tin cases, short primers	22	11.5	7 5	70
Box for 50 tin cases, long primers.	27.5	11.25	7 75	90

The following materials are required for 10,000 friction-primers: 136 pounds sheet-brass, .036 inch thick, 6.75 inches wide, for long primers; 60 pounds sheet-brass, .036 inch thick, 6.75 inches wide, for short primers; about ⅙ returned as scrap; 20 pounds brass wire, .05 inch; 1.25 pound solder; 1.5 pound antimony trisulphide; 1 pound potassium chlorate; .125 pound flowers of sulphur; .094 pound gum arabic; 7.5 pounds beeswax; 2.5 pounds rosin; 11 pounds musket-powder; 2 quarts pine-tar; 1.25 quart varnish (.75 pound shellac, 1 quart alcohol, .25 ounce lamp-black); .5 pint alcohol for friction-composition. See *Electric Primer, Fire-works, French Friction-tube, Maynard Primer,* and *Percussion Primer.*

FRILL.—An ornamental appendage to the shirt which officers and soldiers generally wore with regimentals. A small aperture was usually made at the top to admit the hook and eye of the uniform-coat. Enlisted men generally wore frills detached from the coat.



Frog of Officer's Overcoat, U. S. Army.

FRISRUTTER.—An instrument made of iron and used for the purpose of blocking up a haven or river. The beams through which the upright bars pass are usually 12 feet in length, and the upright bars that go through the beam are of such length that when the frisrutter is let down into the river, they will at high water reach within 5 feet of the surface.

FROCK.—In the British service, the undress regimental coat of the Guards, Artillery, and Royal Marines.

FROG.—1. A button or toggle of spindle shape and covered with silk or other material, which is passed through a loop on the opposite side of the breast of a military cloak or overcoat, serving to fasten the two breasts together. The drawing represents the frog or agraffe for officer's overcoat as at present worn in the United States army.—2. The loop of a bayonet- or sword-scabbard.—3. A horny wedge-shaped substance within the cavity of a horse's hoof. The function of the frog is to share in the pressure on the foot, and by its elasticity to relieve or distribute the pressure on the hoof.

FROGGED.—A term used in regard to uniforms, and applied to stripes or workings of braid or lace, as ornaments, mostly on the breast, on the plain cloth of which a coat is made.

FRONDE.—A sling used in France by the Huguenots at Sancerre, as late as the year 1572, in order to save their powder. There were two kinds, the one which was used in throwing a stone from the arm, and the other fixed to a lever and so contrived that a large quantity of stones might be thrown into the enemy's camp. The *fronde* or sling was used by the Romans on three different occasions, viz.: when they sent their light-armed men, called *Velites*, forward to skirmish before a general engagement; when they wished to drive the enemy from under the walls of a town which they were preparing to storm; and finally to harass and wound the men in the enemy's works. This weapon, together with the bow and arrow, may be numbered among the primitive arms of mankind.

FRONT.—1. A word of command signifying that the men are to face to their front; also to cast their eyes to the front after dressing.—2. The opposite to rear. The front, with reference to an alignment, is the direction of the supposed enemy. Used as a general term, the word signifies the direction in which soldiers face when occupying the same relative positions as when last told off. The front in artillery is the direction to which the horses' heads turn when the battery is limbered up.

FRONTAGE.—This term is expressive of the ground troops in line occupy either on parade or in camp. Cavalry in one line requires one yard to each file, and 12 yards between squadrons. Artillery in line, whether a field or horse-artillery battery, occupies 95 yards, and 19 yards between battery and battery, or between other troops. The frontage required by infantry is 2 feet per file, with intervals of 30 paces between battalions. In camp, the frontage, as a general rule, of cavalry and infantry should correspond with the space covered by the regiments when deployed into line (allowance being made for intervals between corps), and the lines of tents should be on the prolongation of the squadrons or companies as they stand when in column. When troops are encamped in two or three lines, from 200 to 500 yards should be left clear between the rear of one line and the front of that behind. The frontage of a battalion of infantry in camp on war establishment occupies 320 yards, a regiment of cavalry 256 yards, and a battery of artillery 110 yards.

FRONTAL.—The metal face-guard of the soldier. The term is frequently applied to anything worn on the face or forehead.

FRONTIER DEFENSE.—Military engineers, and other writers on this branch of the military art, have proposed systems of defensive lines for retarding an assailant at the frontier, of a more or less complicated character; the point aimed at in all cases being to make the works of each line of sufficient strength to defy an open assault even when their garrisons are reduced to their least number, and to combine this obstacle with the active effort of an army holding the open field, and maneuvering in connection with the fortified points, to threaten the flanks and rear of an invading force that might attempt to force its way through the defensive lines without carrying some of the works by a siege. Although hypothetical cases of this character do very well to hang an argument upon, they are of little practical use, as the points that must necessarily be fortified will be those which lie upon the main avenues of access to the interior from the frontier; as upon these also must lie the principal centers of population from the frontier to the interior. The problem in each case will be therefore a special one, and must be treated upon its own data. In the organization of the inland frontier fortifications of a State, the points to be principally regarded are the principal avenues of access to it, and their topographical features as they lend themselves more or less to strengthen the artificial defenses. In conducting an invasion across an inland frontier, the march of the enemy must necessarily be along the roads that intersect it, as these afford the only means for transporting the *matériel*, etc., of the army. The points, therefore, or places in their neighborhood where the principal roads or other avenues of communication cross the frontier, particularly those which lead to the great centers of population and wealth, are the ones which would necessarily call for permanent defenses. No absolute rule can be laid down for the distribution and strength of such works along a frontier. Everything must depend upon the more or less of facility presented to an enemy for penetrating at one point rather than another, and of the ulterior advantages the one may present to him over another. Rivers and mountain-ranges are the natural fortifications of States; and where they form the frontiers they greatly facilitate the application of artificial defensive means, as they present but few, and those in general, important points of access. When these points on a river are fortified, an invading force, however powerful, cannot without great risk cross the river without first gaining possession of them; for, even should a sufficient detachment be left to observe and blockade the fortresses, the main army, in case of retreat or any disaster, might be placed in an extremely critical position, in its movements to recross the river, with the garrisons of the fortresses threatening its flanks and rear. In offensive operations fortresses upon a river frontier form one of the strongest bases of operations. If a river intersects the frontier, the point where it crosses it, or some one in its vicinity, should be occupied by a permanent work; among such points those are more peculiarly necessary to be held where a river forming the frontier is intersected by another navigable one which lies wholly within the frontier. The importance of thoroughly occupying such points is obvious, as they afford an army on the defensive the means of passing readily and safely from one side to the other of the river, either to evade a force too powerful for it to cope with in the open field, or when an opportunity offers, from any imprudent movement of an invading force on one side, to throw itself suddenly from the other on its flank or rear, and thus forcing it to a retrograde movement. With respect to mountain-passes, the main roads alone will require permanent works. If the passes are independent of each other, a work will be necessary for each one separately; but where several unite at the same point, upon or within the frontier, a single work placed upon this point will suffice. Local circumstances will determine the point in each pass which, occupied, will offer the greatest advantage for obstructing the march of an invading force, and retarding the bringing forward its *matériel*. The only rule that can be given is that, whilst the position selected shall satisfy these conditions, there shall be every facility of communication between the fortress and the interior for receiving supplies and reinforcements. This rule would lead generally to the selection of some point of the outlet within the frontier as the proper one. In the case of important commercial cities and large naval depots lying within harbors more or less accessible both to sea and land attacks, the character of the defenses called for must necessarily be commensurate with the magnitude of the interests to be guarded, and the consequent temptation to an enemy to put forth great efforts for their occupation and destruction. The avenues of approach to these objects by sea, which can be brought within range of cannon and mortars in fortifications on the shore, or in casemated works erected on natural or artificial islands, should be occupied to a distance that will prevent a fleet from approaching near enough to open a bombardment, and if practicable also force the enemy, if he ventures a land-attack, to disembark his forces either at so great a distance from the object to be reached that he will not be able, by a sudden movement of this nature, to effect a surprise, or to limit his landing to such points on the coast as, from their exposed position, may render the co-operation of the naval and land forces very uncertain, and, in case of a storm, place the latter in a very perilous condition if attacked. These works will form the exterior chain of the defenses. Within these, batteries either open or casemated, as the locality may seem to demand, should occupy all the most suitable positions for sweeping the path that a fleet must follow by powerful cross, direct, and enfilading fires, and for reaching every point of anchorage within the harbor. On the land-approaches, points should be occupied by forts of a permanent character, which will prevent a sufficiently near approach to bombard the city or depot, and, in combination with temporary works, will afford an intrenched field of battle for the troops on the defensive. These will form the exterior line of the land-defenses, the interior line being either a continuous enceinte of permanent fortification, which will require a regular siege for its reduction, or else a suitable combination of either continuous or detached field-works of such strength and armament that the enemy, in any attempt to carry them by an open assault, will be made to suffer heavily even if he is not repulsed. The security of objects of this character will be greatly increased when they lie at some distance within the sea-coast frontier, and can only be approached by water through such comparatively narrow defiles as even our largest rivers present, and by land after one or more marches. These defiles will, for the most part, not only present admirable positions on their banks, from which an assailant's fleet can be enfiladed within the range of the heaviest guns, but frequently others, at points where the river narrows, or changes its course, where works occupying the opposite banks will give the means of rendering the river impassable by torpedoes, booms, rafts, or other floating and sunken obstructions, which cannot be removed except by getting possession of the defenses by which they are guarded, by a land-attack. In the great military States of Continental Europe, the question as to what extent the great centers of population and wealth in the *interior* should be covered by fortifications has been submitted to the investigation of the ablest engineers and statesmen, from the time of Vauban down to the present day. Whatever differences of opinion have been called forth as to the mode of accomplishing this object, as shown in the published views on the proposition to fortify Paris, there seems to have been none among those best qualified to decide upon it as to the great importance of so fortifying this Capital and other large places in the interior, as Lyons, etc., which from their position must be of the highest strategical value in the case of a successful invasion by a large army, as not only to prevent their wealth and resources from falling into the possession of the invading force, but to make them safe rallying-points for beaten and dispersed forces, and depots for organizing new armies. The plan that has been adopted for this end, both in France and in most of the other cities of Europe which have been either newly fortified or had their old works strengthened within this period, is to surround the city by a continuous enceinte of greater or less strength, but one secure from a *coup-de-main*, and to occupy with forts of a permanent character the most suitable points in advance of the enceinte, to prevent an enemy from bombarding the city, or penetrating between them without first gaining possession of them. By this plan it is proposed to gain all the advantages offered by the passive resistance of fortifications and the activity of a disposable movable force occupying the zone between the enceinte and the forts as an intrenched camp, upon which the forts with temporary works thrown up between them would render an open assault too perilous to be attempted. As to what future changes will be called for in permanent fortifications, both for inland and sea-coast defense, time alone can develop. Judging from the increasing size and range of cannon, and their greater destructive effects, it is probable that wrought-iron will have to be substituted for stone in positions where the latter is exposed to the heavy projectiles coming into use, as this material and earthen parapets will alone afford an indestructible cover against such projectiles. Still, when we look to the time and care which are given to the erection of permanent works, the great superiority they have over temporary structures for the planting and handling the heaviest cannon, besides the difficulty which the transportation of such enormous weapons offers to their use by the assailant, there is no reason why these changes should not inure to the advantage of the defense, both on land and water fronts. In the defense of harbors and rivers against the most imposing means of attack by heavily armed iron-clad steamers, there is every reason to suppose that adequate means will be found, in floating and stationary obstructions, like bombs and torpedoes, combined with iron-clad floating batteries, to secure them from all hazard. See *Fortification* and *Permanent Fortification.*

FRONT OF COUNTERGUARDS.—A certain number of counterguards so disposed as to mutually flank each other.

FRONT OF FORTIFICATION.—All the works constructed upon any one side of a regular polygon, whether placed within or without the exterior side. Some authors give a more limited sense to the term, by confining it to two half-bastions joined by a curtain.

FRONT OF OPERATIONS.—All that part of the theater of operations in front of the successive positions occupied by the army as it moves forward. See *Strategy.*

FRONT SIGHT.—A sight usually attached to the barrel, near the muzzle, by means of a horizontal screw at right angles to the barrel, which allows a horizontal motion to the right or left of the true position, which is marked by the 0 of the scale and vernier. To assure the vertical position of the sights, a level is attached to the rear of the front sight, and has a colored liquid, which renders the bubble more distinct to the marksman in aiming.

The shape of the sight proper is a subject about which there is much difference of opinion among marksmen, some preferring one variety and others another. Provision is made for the ready substitution of sight-pieces of different kinds. The drawings show some of the varieties most commonly used by the best marksmen. To avoid the reflection of the sun on the sights, they should be blackened with smoke, or, better, by lamp-black mixed with shellac varnish, and applied with a small brush. A shade made of metal or card-board, and painted black or dark green, incloses the end of the barrel for a distance of three inches. See *Sight.*

Front Sights.

FRUMENTARIUS.—A Roman soldier whose duty was to bring supplies of provisions to the army, and the earliest notice of all hostile movements. They were also, under the Roman Empire, officers who acted as spies in the Provinces and reported to the Emperor whatever seemed worthy of note. They appear to have derived this appellation from their gathering news in the same way that the Frumentarii or Purveyors collected corn.

FUEL.—This term is generally applied to combustibles used for the production of heat; also, less frequently, to combustibles such as oil, paraffine-oil, used for lighting. Under articles Coal, Coke, etc., will be found details of the physical properties and chemical composition of the various fuels; the following observations bear chiefly on their economical application as sources of motive power. The two elementary bodies to which we owe the heating powers of all our fuels, natural and artificial, are carbon and hydrogen. Coke, wood-charcoal, peat-charcoal, and anthracite contain little or none of the latter element, and may be regarded as purely carbonaceous fuels. But wood, peat, and most varieties of coal contain hydrogen as well as carbon; and in their combustion these two substances combine to produce volatile and combustible hydrocarbons, which are volatilized previous to being consumed, while a purely carbonaceous fuel evolves no volatile matter until combustion has been effected. These hydrocarbons are numerous and varied in composition; but when combustion is perfect, the amount of heat produced by any hydrocarbon is exactly what would have been produced had the hydrogen and carbon been burned separately. It will be of advantage, therefore, to study these two elementary combustibles in succession, in order to estimate subsequently the combined effect where they come together in the same fuel. The heating power of a combustible, or the *amount* of heat generated by it, is usually expressed in degrees Fahrenheit on so many pounds' weight of water. But in estimating the *temperature,* or intensity of heat produced, we have to keep in view that different substances have different capacities for heat—that of water being generally assumed as unity. The number expressing this capacity is called the specific heat of the substance. Water 1000, carbonic acid 221, imply that while 1000 units of heat are required to elevate the temperature of water any given number of degrees, only 221 units are required to elevate to the same temperature an equal weight of carbonic acid.

CARBON AS FUEL.—1. *Amount of Air required for Combustion.*—Burned in air, carbon combines with the oxygen to form carbonic acid (CO_2), mingled with nitrogen, the other atmospheric element. The chemical change may be thus represented, atomically:

			Products of Combustion.	
Carbon,		6.0		
Air (69.6)	Oxygen,	16.0	Carbonic acid,	22.0
	Nitrogen,	53.6	Nitrogen,	53.6
		75.6		75.6

Or, assuming carbon as unity:

Carbon,		1.000		
Air (11.6)	Oxygen,	2.667	Carbonic acid,	3.667
	Nitrogen,	8.933	Nitrogen,	8.933
		12.600		12.600

Carbon therefore requires about twelve times its own weight of air for perfect combustion.

2. *Amount of Heat Produced.*—Andrews found that 1 lb. carbon produced heat equal to 1° F. in 14,220 lbs. of water. Other observations agree very closely. This may be otherwise stated thus: 1 lb. carbon will raise from freezing to boiling point (32° to 212° = 180°) $\frac{14220}{180}$ = 79 lbs. water; from mean temperature to boiling-point (60° to 212° = 152°) $\frac{14220}{152}$ = 93.5 lbs. water; will boil off in steam from mean temperature (60° to 212° = 152°, add latent heat in steam 965° = 1117°) $\frac{14220}{1117}$ = 12.73 lbs. water; and will boil off in steam from boiling-point (latent heat in steam 965°) $\frac{14220}{965}$ = 14.74 lbs.

3. *Utmost Temperature or Intensity of Heat from Carbon.*—Here we suppose the combustion effected in a space inclosed by non-conducting material, so that all the heat produced by 1 lb. carbon is retained by the products of its combustion. Caloric sufficient to raise 14,220 lbs. of water 1° F. is thus compressed, as it were, into 12.6 lbs. of carbonic acid and nitrogen. To determine the temperature thus produced, we require to know the specific heat of this gaseous compound, that of water being 1.

3.667 lbs. carbonic acid.	Specific heat	2210
8.933 " nitrogen.	" "	2754
12.600 " products of combustion.	Mean sp. "	2596

14,220° on water at 1.000 specific heat will give 54,776° on these products per pound weight. Distributed over 12.6 lbs., this heat will raise the temperature to $\frac{54776}{12.6}$ = 4347° F., which is therefore the utmost intensity of heat attainable in burning carbon, supposing no loss by absorption or radiation.

4. *Effect of Excess of Air.*—Excess of air has been proved to have no effect on the *quantity* of heat produced where combustion is perfect; but the intensity of *temperature* is diminished. Suppose two equivalents of air admitted; we then have as the products of combustion—

3.667 lbs. carbonic acid.	Specific heat	2210
8.933 " nitrogen.	" "	2754
11.600 " air in excess.	" "	2669
24.200 " products.	Mean sp. "	2631

14,220° on water = 54,048° on this new mixture of gases. But the heat is now diffused over 24.2 lbs. matter instead of 12.6 lbs., $\frac{54048}{24.2}$ = 2347° F.: the utmost temperature produced by carbon burned in two equivalents of air. The utmost temperatures attainable, with various proportions of air, are given below, and also the appearance which the interior of the furnace would exhibit. Flame at these temperatures will present the same differences in color.

WEIGHT.		Ratio of Fuel to Air.	Highest Possible Temperature.	Appearance of a Body exposed to such Temperature.
Carbon.	Air.			
lbs.	lbs.			
1	11.6	1 to 1	4347°	Intensely brilliant.
1	17.4	1 " 1½	2951	Dazzling white.
1	23.2	1 " 2	2233	Bright ignition.
1	29.0	1 " 2½	1797	Full cherry red.
1	34.8	1 " 3	1503	Commencing cherry red
1	58	1 " 5	908	Incipient red.
1	69.6	1 " 6	758	Black.

5. *Effect of Deficiency of Air.*—If, before reaching the superior layers of carbon or cinder, the air has parted with all its oxygen to form carbonic acid with the production of heat, then the carbonic acid combines with part of the remaining carbon to form carbonic oxide, CO, but without producing heat. The loss may amount, therefore, to one half of the fuel: some have stated it as high as three fourths. If this oxide, when it gets above the fuel, meet with air before cooling, it burns with a pale blue flame, restoring part of the lost heat; but to what extent has not yet been determined.

6. *Effect of Water Present.*—Passing into a vapor, water absorbs both sensible and latent heat, and thus diminishes the temperature. Heating power is also lost, as products of combustion are generally passed into the atmosphere at a high temperature.

HYDROGEN AS FUEL.—1. *Air Required.*—Hydrogen combines with the oxygen of the air to form vapor of water, mingled with nitrogen:

			Products of Combustion.	
Hydrogen,		1.0		
Air (34.8)	Oxygen,	8.0	Vapor of water,	9.0
	Nitrogen,	26.8	Nitrogen,	26.8
		35.8		35.8

1 lb. hydrogen therefore requires 34.8 lbs. air, while 1 lb. carbon requires only 11.6 lbs.

2. *Amount of Heat Produced.*—The amount of heat produced from hydrogen is much greater than that from carbon; the caloric from 1 lb. heating 60,840 lbs. water 1° F. Part of this is, however, latent in the water-vapor, and must be deducted in calculating intensity of heat, and also heating effect under all ordinary circumstances. This deduction amounts to 9 lbs. water × 965° latent = 8685°, leaving 52,155° as the effective heating power of 1 lb. hydrogen.

3. *Utmost Temperature or Intensity of Heat.*—This is *less* than in the case of carbon, in consequence of the high specific heat and greater quantity of the products. We have—

Vapor of water........	9 lbs.	Specific heat	8470
Nitrogen...............	26.8 "	" "	2754
	35.8 "	Mean sp. "	4191

52,155° on water will be 124,445° on these products; and $\frac{124445}{35.8}$ lbs. = 3476° is the utmost possible temperature.

4. *Effect of Excess of Air.*—As in the case of carbon, the intensity of heat is diminished, as under:

Weight. Hydrogen.	Weight. Air.	Ratio of Fuel to Air.	Highest Possible Temperature.
lbs.	lbs.		
1	34.8	1 to 1	3476°
1	69 6	1 " 2	2187
1	104.4	1 " 3	1591
1	139.2	1 " 4	1250

5. *Effect of Deficiency of Air.*—No new product is the result of deficiency of air, as in combustion of carbon; the hydrogen simply escapes unconsumed.

6. *Effect of water-vapor present* is diminution of intensity and ultimate loss of heat in application, as in the case of carbon.

Temperature of Ignition of Carbon and Hydrogen.—These substances must be themselves heated before they can burn. Hydrogen begins to burn at or below 300°, while carbon requires a red heat (800° to 1000° F.), and even at that temperature burns very slowly. Consequently, where they are combined, as in common coal, the temperature present is often sufficiently high to ignite and consume the hydrogen, while the carbon remains unchanged as cinder or passes away as smoke, unconsumed in either case. All that has been said above of carbon, as to air required, heating power or value, utmost temperature, temperature of ignition, effect of water present, and of excess or deficiency of air, applies without modification to one class of fuels—the purely carbonaceous, including anthracite, coke from coal, charcoal from wood and peat, and the cinder of any description of fuel. The incombustible ash must be allowed for in calculating heating power or value; and also the volatile bodies—nitrogen, sulphur, etc.—the latter of which frequently renders the fuel unsuitable for many purposes in the arts and manufactures. Peat, wood, and coal, with the exception of anthracite, contain hydrogen to an extent rarely exceeding 5 per cent. We have seen that, compared with carbon, hydrogen requires three times as much air, and generates nearly four times as much heat, but produces 20 per cent less intensity of heat, and ignites at a much lower temperature; and the combustion of wood, coal, etc., is in these respects modified according to the proportion of hydrogen present in them. The following table shows the composition of British coal, as determined by Playfair and De la Beche. Columns 8 to 12 are added to illustrate the process of combustion.

The elements of a hydrocarbon are consumed, not simultaneously, but in succession. First, the carbon is separated from the hydrogen in light floating particles, subsequently seen as soot or smoke (if not consumed); then the hydrogen burns, and communicates heat to the carbon particles, which then appear as flame. The color of the flame indicates the temperature present; and if the temperature is sufficiently high, the carbon of which the flame is composed burns also, producing a further increase of heat. If not, the flame, as it moves onward, cools, becoming red, dull red, and finally black and smoky, passing away as such. For complete combustion of common coal, we therefore require not only air in sufficient quantity, but also intensity of heat above the fuel. We require a low temperature to separate the carbon from the hydrogen; a higher temperature to consume the hydrogen; and a still higher to consume the carbon of the flame. In closed furnaces, such as those of steam-boilers, while the current of air supplied continues pretty uniform in quantity, the volatile bodies are evolved almost immediately after fueling; and would require, for the moment, perhaps four times the quantity of air which is passing through. The volatile fuel is, in consequence of the want of air, carried off partly unconsumed; and the temperature in such furnaces is frequently too low for the ignition of carbon, as may be seen from the color of the flame; the cold boiler having abstracted the heat before the flame has been subjected to its influence. From the principles involved, we should expect most success where the fuel is supplied by mechanical arrangements as regularly and uniformly as the air, and where, in addition, the body of the furnace is protected or removed so far from boiler-surface and all other cooling agents as is necessary to maintain a temperature within it sufficient for the thorough ignition of the flame. See *Cupola-furnace*.

FUGLEMAN.—An intelligent soldier posted in front of a line of men at drill, to give the time and an example of the motions in the manual and platoon exercises. He originally stood in front of the right wing, and hence the name. The word is frequently written *Fugelman*, and more properly *Flugelman*, from the German *flügel*, a wing.

FULCRUM.—The cast-iron post at the breech of a large cannon used as a support for an iron bar in giving elevations; called also *ratchet-post*. See *Lever*.

FULL BASTION.—When the interior is filled up to the level of the terre-plein of the rampart, the bastion is called *full*. See *Bastion*.

FULL CHARGES.—The charges of powder required

Locality.	Average Composition.					On Distillation, there is — Left as Coke or Cinder.		Expelled in Gaseous Form.				Proportion of Hydrogen to Carbon.
	Carbon.	Hydrogen.	Water = Hydrogen and Oxygen.	Sulphur and Nitrogen.	Incombustible Ash.	Ash.	Carbon.	Water, Sulphur, and Nitrogen.	As Volatile Hydrocarbons. Hydrogen.	Carbon.	Total.	
Wales	83.78	4.27	1 67	2.41	4.91	4.91	67.69	6 68	4.27	16.09	20.36	1 to 3
Newcastle ...	82 12	4 60	6.40	2.59	3.77	3.77	56.90	8.99	4.60	25.22	29.82	1 " 5.5
Lancashire ..	77.90	4 53	10.72	2.74	4.88	4.88	55.34	13.46	4.53	22.56	26.69	1 " 5.4
Scotland. ...	78.53	4 40	10.90	2.11	4.03	4.03	50.19	13 01	4.40	28.34	32.74	1 " 6.4
Derbyshire...	79.68	3.66	11.56	2.42	2.65	2.65	56.67	13.98	3.66	23.01	26.67	1 " 6.3
	1	2	3	4	5	6	7	8	9	10	11	12

When coal is heated in a retort, it yields volatile hydrocarbons amounting to 20 to 32 per cent of its weight (see column 11). The hydrogen has robbed the fuel of six times its own weight of carbon. When fresh fuel is added to live coal in a furnace, the same result ensues; so that in using coal, 50 to 67 per cent of carbon burn on the grate, and 20 to 32 per cent carbon and hydrogen have to be burned in the open space above the fuel, or escape unconsumed.

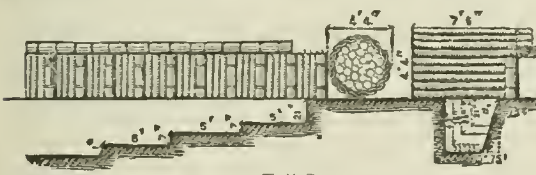
in actual service to produce the best or most useful effect. See *Charge*.

FULLER'S EARTH.—A mineral consisting chiefly of silica, alumina, and water, with a little magnesia, lime, and peroxide of iron. The silica is about 50, the alumina 20, and the water 24 per cent of the whole. It is regarded as essentially a hydrous bisilicate of alumina. It occurs in beds, associated with chalk, oölite, etc.; is usually of a greenish-brown or a slate-blue color, sometimes white; has an uneven earthy fracture and a dull appearance; its specific gravity is from 1.8 to 2.2; it is soft enough to yield readily to the nail; is very greasy to the touch; scarcely adheres to the tongue; falls to pieces in water, but does not become plastic. It has a remarkable power of absorbing oil or grease; and was formerly very much used for fulling cloth, for which purpose it was considered so valuable that the exportation of it from England was prohibited under severe penalties; it is still used to a considerable extent. The annual consumption in England is said to have at one time exceeded 6000 tons. It is found at Nutfield, near Reigate, in Surrey, in cretaceous strata; where there are two distinct beds, the upper one of a greenish color, and 5 feet thick, resting on the other, which has a bluish tint, and is 11 feet thick. It is also found in Bedfordshire, Nottinghamshire, and Kent; and on the Continent in Saxony, Bohemia, and near Aix-la-Chapelle. There is a considerable deposit of it at Bath, where the group of associated blue and yellow clays and marl has received the name of "The Fuller's Earth Series." It is also found at Maxton, in Scotland.

FULL PAY.—The full amount of an officer's or soldier's pay, as fixed by law. In the British service, an officer of thirty years' full pay is permitted to retire on the full pay of his regimental rank, with a rank one step higher than that which he holds by brevet or otherwise.

FULL REVETMENT.—Any revetment is said to be *full* when the wall is carried up to the superior slope of the parapet.

FULL SAP.—The full sap is resorted to, in siege-operations, when the fire becomes so destructive that the flying sap cannot be used. The trench is opened and pushed forward by engineer troops alone; for this purpose a working-party, termed a *brigade*, of eight sappers, is requisite. The brigade is divided into two equal *sections;* the sappers of the first section dig the trench, and are numbered from 1 to 4, No. 1 leading. The other four are termed *assistants;* they bring forward the materials, and assist the first section in all the necessary operations. The leading sapper, No. 1, is provided with a pick and shovel,



Full Sap.

and wears a musket-proof helmet and cuirass; he works on his knees, being covered, on his side toward the defenses, by the parapet of the trench, from which he debouches; and in front by a sap-roller, which is placed perpendicular to the line of direction on which he is to work, and rests against the gabion he is filling, covering it one foot. The portion of the sap which he digs is 21 inches wide at top and 21 inches deep; it receives a slope of 4 perpendicular to 1 base on the front, and is vertical in the rear; and its length is 5 feet. So soon as this portion is finished, No. 2, who is protected in all respects like No. 1, commences to widen and deepen the trench 8 inches at the point from which No. 1 started, and follows on after No. 1, keeping always 5 feet in his rear. When No. 2 has pushed forward 5 feet, No. 3 commences and enlarges the trench in each direction 7 inches; he follows on also 5 feet in rear of No. 2; but as the work thrown up by the sappers preceding him affords pretty good cover, he can work standing, taking the precaution to bend forward for greater security. Finally, No. 4 begins when No. 3 has got on 5 feet, and deepens and widens 7 inches. As he is well covered he can work in an unconstrained posture. Besides the shelter given on the flank by the gabions, as they are successively filled, and by the sap-roller in front, the further precaution is taken of driving sap-fagots along the berm, at the junction of the gabions; these are successively removed as they are no longer requisite. The trench-fascines are placed upon the gabions by the assistants; and the remainder of the trench completed by working-parties of the line, so soon as the brigade of sappers have proceeded far enough for the others to commence without hindrance. See *Sap.*

FULL SIGHT.—An aim in which the entire fore sight is seen when looking through the notch on the rear sight. See *Sight.*

FULMINATE OF MERCURY.—Fulminating-mercury ($2HgO,C_4N_2O_2$) is best prepared by dissolving 3 parts of mercury in 36 of nitric acid of specific gravity 1.34, without the application of heat, in a flask capable of holding 18 times the bulk of the acid. The solution is then to be poured into a large vessel containing 17 parts of alcohol of a specific gravity 0.830, and immediately to be re-transferred to the flask, which is still full of nitrous vapors, and with which it must be well shaken in order to effect their absorption. Effervescence commences after a few minutes, and soon becomes extremely violent; and at the same time there is a deposit of metallic mercury, which is gradually re-dissolved. The reaction must be moderated by the gradual addition of 17 parts more of alcohol; and on cooling, crystals of the fulminate, amounting to 4.6 parts, are deposited. These must be washed with cold water, and dried at 100° F. Fulminate of mercury forms white silky needles.

This is the composition used in the detonating primers employed for the ignition of dynamite and gun-cotton. It is the substance in percussion-caps that detonates and produces fire when the cap is struck a sharp blow. Dry fulminate of mercury explodes violently when heated to 367° F., by the electric spark, or when struck. When wet it is inexplosive, and therefore it is always kept wet, being dried in small amounts when required for use. Great care is requisite in handling it. For the purpose of detonating nitro-glycerine or its preparations 15 grains of the fulminate are sufficient, but to detonate gun-cotton 25 grains are necessary. The fulminate in detonating fuses should be inclosed in a copper case or cap, and must never be loose. The fulminate should be wet when charging the detonators, and afterwards dried.

FULMINATE OF SILVER.—Fulminating-silver ($2AgO,C_4N_2O_2$) is prepared in nearly the same manner as the fulminate of mercury. It is more powerfully explosive than the last-named salt. Even when moist or under water, pressure with a hard body will cause its explosion; and when quite dry, the slightest friction between two hard bodies produces a similar result. The preparation of the fulminates is attended with very considerable danger, and should be attempted by none but professed chemists.

FULMINATES.—All the fulminates are easily exploded, and some are excessively sensitive; the *mercury salt* is the only one of practical value.

The explosive force of the fulminate of mercury is not much greater than that of gunpowder, on account of the small amount of gas given off, but it is much more sudden in its action, and the effect is of a local character. When dry, a violent explosion is produced by a blow; by a heat of 186° (366.8° F.); by contact with some strong sulphuric or nitric acid; by sparks from flint and steel; or by the electric spark. If wet, it is inexplosive.

Fulminate of mercury is formed by the action of mercuric nitrate and nitric acid upon alcohol. One part of mercury is dissolved in 12 parts of nitric acid, and the solution poured into 11 parts of alcohol. The vessel is placed in hot water until the mixture it contains darkens, becomes turbid, and begins to evolve dense white fumes. It is then removed from the water. The reaction is allowed to go on till the liquid clears and the dense white fumes cease; further action is then stopped by filling up with cold water. Should red fumes appear during this operation, cold alcohol must be added to check the violence of the action. The fulminate settles to the bottom of the vessel as a gray crystalline precipitate. The liquid is then poured off, and the fulminate washed several times by decantation or upon a filter.

Fulminate of mercury is used only for igniting other substances. It is employed mainly in percussion-caps, primers, fuses, detonators, etc. It is of special importance from its power to cause the violent explosion called detonation; it has thus become a requisite for exploding gun-cotton, nitro-glycerine, and preparations made from them. The fulminate in a detonating fuse should be contained in a copper case, and must not be loose; on account of danger, it is necessary that it be charged wet.

In the application of fuses to the detonation of modern explosives, some very surprising facts have recently been established which go far to induce a belief that synchronism in vibration is an important element. Thus, compressed gun-cotton may be detonated by 5 grains of fulminating mercury, but requires 50 grains of chloride of nitrogen; it fails with 100 grains of iodide of nitrogen, and even with 124 grains of nitro-glycerine, though the latter develops far more heat and mechanical force. On the other hand, a small initial charge of gun-cotton readily detonates nitro-glycerine. See *Explosive Agents*.

FUMIGATION.—To correct and purify an infectious or confined atmosphere, such as is often found in transports, fumigations are necessary. The materials recommended for the purpose are brimstone with sawdust; or niter with vitriolic acid; or common salt with the same acid. One fluid ounce of sulphuric acid mixed with two fluid ounces of water, and then poured over four ounces of common salt, and one ounce of oxide of manganese in powder, these latter ingredients being previously placed in hot sand, are also recommended. Burning charcoal is also a good disinfectant.

FUNCTIONS.—A mathematical term of frequent occurrence in the solutions of the problems of gunnery. When two or more variables are combined with constants in an equation, and are such that a change of value of one implies a corresponding change of value of one or more of the others, then such variables are said to depend on and to be functions of each other; and the expression of the mode of dependence is said to be a *function* of such variables. If such an expression involves but one variable, it is said to be a function of one variable; if two are involved, to be a function of two variables; and so on. Thus $\sin x$, e^{ax}, $\log x$, $\sqrt{a^2 - x^2}$, are functions of one variable—viz., of x; e^{ax+by}, $\tan(ax + by)$, x^y, are functions of two variables, x and y; so xyz, $x^2 + y^2 + z^2$ are functions of three variables; and so on. Functions are denoted by the symbols F, f, φ, ψ, etc. Thus $F(x)$ means a function of one variable, x combined with constants or not, as the case may be; $\psi(xyz)$, a function of three variables. These functional symbols are *general*, and their specific forms are the particular functions which arise from operations in algebra, trigonometry, etc.

Functions are implicit and explicit. When one variable is expressed in terms of others, it is said to be an explicit function of them; but when all the variables remain involved in one expression, the function is said to be implicit. Thus, $x^2 + y^2 - r^2 = 0$ is an implicit function of two variables, but $y = \sqrt{r^2 - x^2}$ is an explicit function of one variable. In explicit functions, the variable which is expressed in terms of the others is called the *dependent* variable, and the others the *independent* variables. Explicit functions are usually written in the form $z = f(xy)$; implicit, in the form $u = F(xyz) = 0$. Functions, again, are algebraical or transcendental. Algebraical functions are those which involve the operations of addition, subtraction, etc., and of involution and evolution. Transcendental functions are those where the operations symbolized are such as e^x, $\log_e x$, $\sin x$, etc.—i.e., exponential, logarithmic, or circular. Functions, also, are simple or compound according as they involve one or several operations. $y = \sin x$ is a simple function; but $y = \log \sin x$ is compound. Further, functions are divided into the continuous and the discontinuous, the circulating and the periodic. Continuous functions are such as are subject to the following conditions: 1. As the variable gradually changes, so the function must gradually change; 2. The law symbolized by the functional character should not abruptly change. Circulating functions are those whose values lie within certain limits for all values of the variables. $y = \sin x$ is an example at once of a continuous and of a circulating function. A function is said to be periodic when it assumes the form $f^n(x) = x$, signifying that if on x a certain operation f be performed n times, the resulting value will be x. Thus $f(x) = \frac{1}{1-x}$ is a periodic function of the third order. For performing the operation indicated by f the second time on $\frac{1}{1-x}$ as the variable, we have $f^2(x) = \frac{1}{1 - \frac{1}{1-x}} = -\frac{1-x}{x}$; and the third time we have $f^3(x) = \frac{1}{1 - \left(\frac{1-x}{x}\right)} = x$. The functional calculus is a recent growth of the transcendental analysis. The object of the differential calculus is generally to ascertain the changes in functions arising from the continuous and infinitesimal variation of their subject variables. The object of the new functional calculus is, speaking generally, to investigate the forms of functions and their growth, when they are subject to a continuous and infinitesimal change as to form. According to Mr. Price (Treatise on the Infinitesimal Calculus), as the differential calculus investigates properties of continuous numbers, so does the new calculus the properties of continuous functions; and as there is an integral calculus of numbers, so there is an inverse calculus of functions. Of the new calculus, the calculus of variations may be regarded as the main branch. It includes, of course, the subject of functional equations. Functional equations are those in which it is required to determine from equations the forms of the functions entering them.

FUND.—There are several kinds of *Funds* in the United States service, arising from certain savings and assessments, and expended according to certain laws. See *Company Fund*, *Post Fund*, and *Regimental Fund*.

FUNERAL HONORS.—On the receipt of official intelligence of the death of the President of the United States, at any post or camp, the Commanding Officer on the following day causes a gun to be fired at every half-hour, beginning at sunrise and ending at sunset. When posts are contiguous, the firing takes place at the post only commanded by the Superior Officer. On the day of the interment of a General-in-Chief, a gun is fired at every half-hour until the procession moves, beginning at sunrise. When the funeral of an officer entitled, when living, to a salute takes place at or near a military post, minute-guns are fired while the remains are being borne to the place of interment; but the number of such guns is not to exceed that which the officer was entitled to as a salute when living. After the remains are deposited in the grave, a salute corresponding to the rank of the deceased officer is fired in addition to three salvos of artillery or three volleys of musketry. In the event of a Flag Officer of the Navy, whether of the United States or of a foreign country, dying afloat, and the remains are brought ashore, minute-guns are fired from the ship while the body is being conveyed to the shore. If it be in the vicinity of a military post, the flag of the latter is displayed at half-staff, and minute-guns are fired from the post while the procession is moving from the landing-place. These minute-guns are not to exceed in number that which the officer was entitled to as a salute when living. During the funeral of a civil functionary entitled, when living, to a salute, the flag is displayed at half-staff, and minute-guns fired as before; but neither salute nor salvos are fired after the remains are deposited in the grave. On the death of an officer at a military post, the flag is displayed at half-staff, and kept so, between the hours of reveille and retreat, until the last salvo or volley is fired over the grave, or, if the remains are not interred at the post, until they are removed therefrom. During the funeral of an enlisted man the flag is displayed at half-staff, and is hoisted to the top after the final volley or gun is fired. All military posts in sight, or within six miles of each other, display their flags at half-staff upon the occasion of either one doing so. The same rule is observed towards a vessel of war. On all occasions where the flag is displayed at half-staff it is *lowered* to that position from the top of the staff. It is afterwards *hoisted* to the top *before* being finally lowered.

Funeral escorts are allowed as follows: *General Commanding-in-Chief*, a regiment of infantry, a battalion of cavalry, and two batteries of artillery; a *Lieutenant General*, a regiment of infantry, a battalion of cavalry, and a battery of artillery; a *Major General*, a regiment of infantry, two companies of cavalry, and a battery of artillery; a *Brigadier General*, a regiment of infantry, a company of cavalry, and a platoon of artillery; a *Colonel*, a regiment; a *Lieutenant-colonel*, six companies; *Major*, four companies; *Captain*, one company; *Subaltern*, half a company; *Non commissioned Staff Officer*, and a *Sergeant*, sixteen privates, commanded by a Sergeant; *Corporal*, twelve privates, commanded by a Corporal; *private*, eight privates, commanded by a Corporal. An officer's escort, when practicable, is commanded by an officer of the same grade. The escort is formed with the center opposite the tent or quarters of the deceased; arms at a carry; bayonets unfixed; the band on that flank of the escort towards which it is to march. Upon the appearance of the remains, the Commander commands: 1. *Present*, 2. ARMS, and the band plays an appropriate air; arms are then carried, after which the coffin is taken to the flank of the escort, opposite the music. The escort is next wheeled into column of companies, platoons, or fours. If the escort be small, it may be faced by the flank. The procession is formed in the following order: 1. Music; 2. Escort; 3. Clergy and Surgeons; 4. Remains and Pall-bearers: 5. Mourners, including members of the former command of the deceased; 6. Distinguished persons, according to rank; 7. Delegations; 8. Societies; 9. Citizens. The procession being formed, the Commander of the escort commands, 1. *Reverse*, 2. ARMS, and then puts the escort in march. The escort marches in slow time to solemn music; the center of the column having arrived opposite the grave, line is formed facing it. The remains are next brought and placed over the grave, after which arms are presented, the band playing an appropriate air. The music having ceased, arms are *carried*, and the coffin, by direction of the Commander of the escort, is lowered into the grave. The Commander next commands: 1. *Rest on*, 2. ARMS. The funeral services are now completed, after which the Commander commands: 1. *Carry*, 2. ARMS, 3. *With blank cartridges*, 4. LOAD. He then causes the escort to fire three rounds with blank cartridges, the muzzles of the pieces being elevated. The escort is then formed into column, and marched to the point where it was assembled, and is then dismissed. The band does not play till it has left the inclosure. When the distance to the place of interment is considerable, the escort, after having left the camp or garrison, may march in route-step until it approaches the burial-ground, when it is called to attention and the arms reversed. The music does not play while at route-step. In all funeral ceremonies, six pall-bearers may be selected from the grade of the deceased, or the grades next above or below it. If a Commissioned Officer, the coffin is borne by six Non-commissioned Officers; if a Non-commissioned Officer, or private, by six privates. At the funeral of a General Officer, the Commander of the escort, in forming column, gives the appropriate commands for the cavalry, artillery, and infantry, which form in column, from front to rear, in the order named. The trumpeters or field-music sound a march, flourishes, or ruffles, according to the rank of the deceased, whenever arms are presented, after which the band plays an appropriate air. In marching to the cemetery, the trumpeters of the artillery and cavalry may alternate, in playing, with the band of the infantry. If the funeral be for a Mounted Officer, his horse, in mourning caparison, follows the hearse. Should the entrance to the cemetery prevent the hearse from accompanying the escort till the latter halts at the grave, the column is halted at the entrance long enough to take the remains from the hearse, when the column is again put in march. The cavalry and artillery, when unable to enter the inclosure, wheel out of the column, face to the column, and salute the remains as they pass. When necessary to escort the remains from the quarters of the deceased to the church, before the funeral service, arms are presented upon receiving the remains at the quarters, and also as they are borne into chapel. The Commander of the escort, previous to the funeral, gives the clergyman and pall-bearers all needful directions.

The usual badge of military mourning is a piece of black crape around the left arm above the elbow, and also upon the sword-hilt, and is worn when in full or in undress. As family mourning, crape is worn by officers (when in uniform) only around the left arm. The drums of the funeral escort are covered with black crape or thin black serge. See *Honors paid by Troops*.

FUNNEL.—An implement formed of sheet-copper and used for pouring the charges from the powder-measure into the shell. It is of the ordinary shape, the upper edge being turned over, outwards, to slightly stiffen it.

FURLOUGH.—A term usually applied to the absence with leave of non-commissioned officers and other enlisted men, granted at the discretion of the Commanding Officer. In the British service, the term is very generally used in India when a servant of the government proceeds on leave out of the country. The English furlough-pay is as follows: An officer drawing staff pay in addition to the pay of his rank is allowed 50 per cent of his substantive appointment; but in no case can the absentee draw more than £1000 per annum. Officers not on staff duty in India receive half the Indian pay of their rank; but in no case do they receive less than the minimum of £250 per annum.

In the United States, under authority of the 11th Article of War, furloughs for twenty days may be granted by the Commanding Officer of the post or the Commanding Officer of the regiment actually quartered with the portion of it to which the soldier belongs. Furloughs may be prohibited at the discretion of the Officer in Command. They are not granted to soldiers about to be discharged.

A Department Commander may grant furloughs to enlisted men for two months; a Military Division Commander for three months, or he may extend to three months a furlough granted by a Department Commander under his command. The General of the Army may grant furloughs not to exceed four months, or extend to four months a furlough already granted.

Furloughs are not granted by any Commanding Officer to go beyond the limits of the next highest command. To warrant a soldier in going beyond such limits the sanction of the superior authority must previously be indorsed on his furlough. A furlough must have the approval of the Secretary of War to enable the soldier to go beyond the limits of the United States. The prescribed limits are stated in the furlough, and if exceeded the man is liable to arrest and the revocation of his furlough.

In cases of special urgency, where it seems most judicious, and the applicant can show sufficient cause for his inability to pay his own expenses, Department Commanders, in the exercise of a sound discretion, may order transportation tickets to be purchased by the Quartermaster for furloughed soldiers, and where this is done a report of the amount paid for such transportation is made by letter to the Company Commander, who charges the same against the soldier's pay on the next muster-day.

Soldiers on furlough are not permitted to take with them their arms or accouterments.

No payments can be made to enlisted men on furlough, on their descriptive lists, without special authority from the Adjutant General.

The following is the form of a furlough:

To all whom it may concern:

The bearer hereof, ——— ———, a Sergeant (Corporal or private, as the case may be) of Captain ——— ——— company, ——— regiment of ———, aged — years, — feet — inches high, —— complexion, —— eyes, —— hair, and by profession a ———; born in the ——— of ———, and enlisted at ——, in the —— of ———, on the — day of ———, eighteen hundred and ———, to serve for the period of ———, is hereby permitted to go to ———, in the county of ——, State of ———, he having received a furlough from the —— day of ——— to the —— day of ———, at which period he will rejoin his company or regiment at ———, or wherever it then may be, or be considered a deserter.

Subsistence has been furnished to said ——— ——— to the —— day of ———, and pay to the —— day of ———, both inclusive.

Given under my hand at ——— this —— day of ———, 18—.
[Signature of the officer giving the furlough.] ——— ———.

See *Leave of Absence.*

FURNACE.—A contrivance for the production and utilization of heat, for warming, ventilating, cooking, and for manipulation of metals and liquids in the arts. Calcining-furnaces are those in which the solid fuel is mixed with the matters to be heated. Crucible-furnaces are used for melting steel or brass, and the furnace itself is embedded in the mass of heating fuel. Forge-furnaces are such as are in ordinary use by blacksmiths, merely a combination of draught and blowing from a bellows. Blast and cupola furnaces are used in the smelting of iron and other ores, and the fusing of hard metals. In these the stuff to be melted and the fuel are charged in combination in the upper end of a vertical cylinder, and the combustion is produced by air forced in at the bottom. Flame-furnaces are of varied form and character. Their effect is obtained by bringing a flame or current of highly heated gas into contact with the thing to be acted upon, instead of imbedding the substance with the fuel. The well-known reverberatory furnace, with fire-grate, flume-chamber, etc., is so arranged that by means of a low arched roof the flame is reverberated or turned back upon the material to be operated upon. Gas-furnaces have recently come into use; there are five or six different kinds. There are furnaces for burning powdered fuel, for natural gas, and for petroleum. Furnaces are also very largely used in glass-making, and in metallurgy and iron-manufacture.

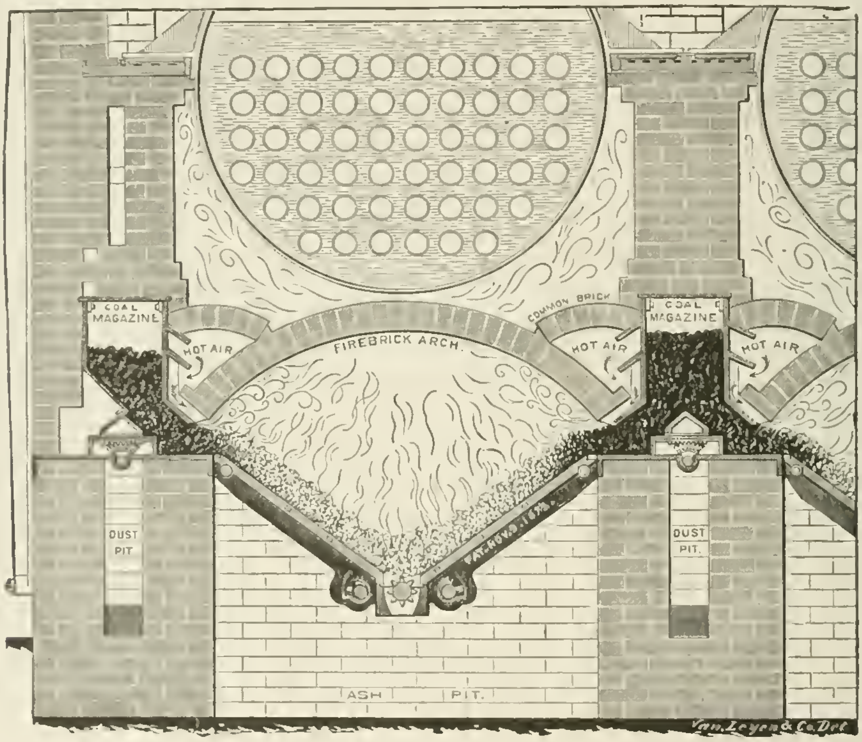


Fig. 1.

The most perfect and satisfactory furnace for general armory and laboratory use is known as the Murphy Smokeless Furnace, and shown in section in Fig. 1. Unlike other furnaces, the more it is crowded the more perfect combustion. The grates are kept constantly in motion, the clinkers cannot form upon them, hence air always passes between them and keeps them cool. The furnace is especially adapted to the use of fine or slack coal, which is put into large hoppers or magazines. By referring to the drawing, there will be seen a casting resting on the brick-work. This is a coking-plate. The inclined grates rest against it at their upper ends. On this plate is placed the inverted open box, called the stoker box. It has a ratchet in each end; a shaft, worked from the outside, has a section of a pinion

[illegible]

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fitted to each ratchet, moving the stoker-box back and forth on the coking-plate every six, ten, or fifteen minutes, as may be required. These stoker-boxes push the coal on to the edge of the coking-plate and grates; the coal then slides down toward the center of the furnace by its own gravity. The triangular piece above the box moves out and in by a lever from the outside, which divides the coal and helps bring it down in front of the stoking-boxes. Immediately over the coking-plates and on the side of each magazine is the arch-plate, on which the fire-brick arch rests. Where the brick come in contact with the plate there are ribs about an inch apart on which the brick are placed. This leaves a small space between each rib. Air is admitted in front of the furnace, regulated by a damper; it passes up through a flue in the brick wall, then over the arch, and there takes up the heat from the brick-work, passes down through the little openings and gives to the fresh fuel on the coking-plate its supply of air; not only that, but it is hot enough in itself to ignite any gases evolved, consequently immediate combustion takes place, and no smoke is made. By the time the coal reaches the grate the bituminous part is consumed, and what remains is coke. This gets its needed supply of air through the grates. Less than a one-horse-power engine is placed at the side; to this is attached a bar running across the front of the furnace. This bar is connected by links to arms which move the stoking apparatus, shake the grate-bars, and, if desirable, the clinker-breaker can be connected in the same manner.

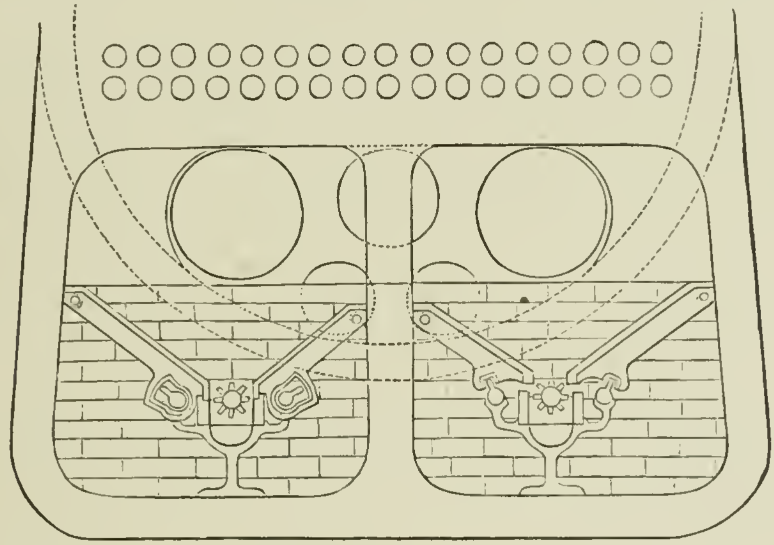
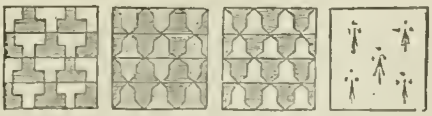


Fig. 2.

The operation of the grates is very simple and effective. Fig. 2 shows their arrangement in a recent United States Government test. The whole apparatus consists of an inclined shaking grate combined with a clinker-crusher and refuse-remover. The purpose of this combination is, without opening the furnace-door or using fire-tools, to keep the fires free of ashes and holes, to crush the clinker into small pieces, and to remove from the furnace all refuse, whether ash or clinker, resulting from the combustion of the coal, these operations being performed by simply working levers placed outside the furnace. This is effected by arranging the grate-bars at right angles to, instead of parallel with, the length of the furnace, inclining them so as to form a hopper, and making the alternate bars stationary and vibrating, the latter being pivoted at their upper ends upon the upper ends of the former, and vibrated up and down by means of a continuous feather on a horizontal bar lying lengthwise the furnace in pillow-blocks at the front and back of the furnace, and moved forward and back on its axis by a lever attached to an end protruded from the ash pit into the fire-room. At the bottom of this grate, and entirely independent of it, is a horizontal bar lying lengthwise the furnace in pillow-blocks, bristling with projecting teeth, and capable of being either vibrated forward and back or revolved entirely around its axis by a lever attached to an end protruded from the ash-pit into the fire-room. This is the clinker-crusher and refuse-remover. The crushing is done by the teeth of the vibrating or revolving bar, and the removing is done by the same process at the same time, the entire refuse falling from the furnace between the lower edge of the inclined grate and the side of the crusher along the lengthwise center of the ash-pit. The drawing shows the crusher-bar placed nearly but not exactly at the center, the grate forming two planes, one on each side of this bar, inclining from the horizontal at an angle of 45°, or forming a right angle with each other. The inner shape of the whole apparatus is that of a *hopper* with vertical ends, or, more nearly, that of an ordinary *hod*. A simple arrangement is for the grate to consist of only one inclined plane extending nearly across the furnace, instead of two inclined planes, each extending across nearly half of the furnace, and for the crusher to be placed against one side of the furnace, thus dispensing with one of the vibrating bars. See *Cupola-furnace* and *Iron*.

FURS.—In Heraldry, shields being often covered with the skins of wild animals, on which the fur was left, there came to be certain kinds of fur which were used in coat-armor, as well as in trimming and lining the robes of knights and nobles, and the mantles



Potent. Counter-vair. Vair. Ermine.

which were represented as surrounding the shields. The principal heraldic furs are: 1. Ermine of which the field is white, and the spots black; 2. Ermines of which the field is black and the spots white; 3. Erminois, which has the field gold, with black spots; 4. Vair, which consisted of pieces of the shape of little glass pots. It is said that the furriers used such glasses to whiten furs in, and because they were commonly of an azure (blue) color the fur in question came to be blazoned *argent* and *azure*; whilst counter-vair, in which the cups are represented as placed base against base, in place of edge to base, as in vair, was *or* and *azure*. 5. Potent and counter-potent, which are supposed to resemble the heads of crutches, placed differently, but having the same tinctures—viz., azure and argent.

FUSE.—Fuses for projectiles may be classified as time-fuses, percussion-fuses, and combination-fuses. The *time-fuse* serves to explode a projectile during flight, or at the end of a given period of time after its discharge from the gun. The *percussion-fuse*, rifled guns, serves to explode projectiles at the instant of striking a resisting object. The *combination-fuse* serves to explode a projectile either during flight or on impact.

TIME-FUSES.—The time-fuse is composed of a column or ring of fuse-composition, driven or pressed into a suitable metal, wood, or paper case. The proportions of the composition vary according to the time it is intended to burn. The service time-fuses comprise three varieties, viz., *wooden-case mortar-fuses*, *metal-case* (Bormann) *fuses*, and *paper-case fuses*.

Fuses for Mortar-shells.—The hard, close-grained woods are best adapted for making fuses; beech or ash is generally used. It should be dry, sound, free from sap, knots, worm-holes, or shakes. To turn the fuse-plug, a helper saws the plank into lengths equal to that of the fuse, and then into prisms, taking off the edges, and centering it on each end. The turner puts the fuse-plug thus roughed out in the lathe, turns its exterior, and graduates it, by means of a steel gauge, into inches and tenths of an inch, commencing at the bottom of the cup. When a number have been turned, the turner puts each fuse-plug into a chuck, bores it, and makes the cup with a tool for that purpose. The fuse-plugs should be carefully inspected, and verified with gauges, and those rejected which have splits, knots, or worm-holes, or which have not the proper dimensions. One turner can turn 500 fuse-plugs, or turn and bore 250, in ten hours.

The following utensils are required for driving the fuses: *driving-blocks*, with holes of the size of the fuse-plug; *benches; mallets*, for the 13-inch, 10-inch, and 8-inch fuses weighing 1 pound, for smaller fuses weighing ½ to ¾ pounds; *steel drifts*, shod with copper, the shortest with a mark .2 inch from the end, *copper ladles*, to contain sufficient composition to make a height, when driven, equal to one diameter of the bore; *copper pans; brushes*.

The composition for 8- and 10-inch light mortar-fuses is 2 parts of niter, 1 of sulphur, and 3 of mealed powder; for 10- and 13-inch heavy mortars, 2 of niter, 1 of sulphur, and 2¼ of mealed powder. The composition must be thoroughly ground and mixed with a muller, or in a leathern barrel, with brass balls. The time of burning will vary according to the quality of the materials used (especially of the mealed powder) and the degree of their admixture. Trials should be made with each composition by driving several fuses and getting their time of burning. There should not be any great variation in the times of burning of the different fuses of the same composition. Fuse-composition should be prepared only a short time before being used, and should be preserved in close vessels in a dry place.

When driving, the workman is seated, his driving-block in front of him, and a bench to hold a pan of composition at his right hand. He takes a fuse, cleans it of all foreign matter, inserting the drift to the bottom of the bore. He then drops the fuse-plug into the driving-hole, takes a ladleful of composition, passing the drift along the edges of the ladle to strike off the surplus; pours the composition into the fuse-plug, strikes it two gentle blows with the mallet, inserts the drift, pressing it down on the composition, giving the fuse two slight blows to settle the composition. The workman strikes the drift twenty-one blows in volleys of three, raising the mallet about one foot each blow, and moving the drift after each volley. He puts in another ladleful, and continues as for the first. Care should be taken to put in equal charges of composition each time, and to give to each ladleful the same number of blows and with the same force. Fuses are often driven by pressure in a screw-press.

Fuses are all driven to the same height by means of a mark on the short drift, or the composition is bored out with the gouge to the same depth. They are primed with mealed powder for about .2 inch, driven with the same force as a ladleful of composition. The cup is filled with a paste of mealed powder and spirits of wine or strong whiskey, and laid aside to dry; it is then covered with a small piece of paper, over which is pasted a cap of strong, water-proof paper, marked with the number of seconds the fuse burns to the inch.

Time-fuse for Guns.—This fuse consists of a *paper case* charged with fuse-composition; it is inserted, at the time of loading the gun, into a brass or wooden plug previously driven into the fuse hole of the shell. The following utensils are required for making the cases: *pattern* of wood, in the form of a rectangle joined to a trapezoid; *iron former*, .35 inch diameter; *knife; glue-pot; brushes*.

The paper is cut to the proper size by means of the pattern. The whole length of the strip must be determined by a trial for each kind of paper, to give the case the proper diameter. The strip is rolled hard on the former, beginning with the large end, and is glued after the first turn. When the case is dry, it is smoothed with a fine file or sand-paper.

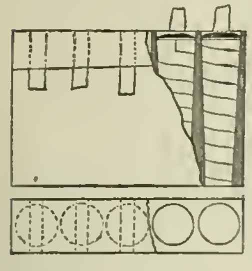
There are different compositions used, one inch burning 2.5, 5, 10, 15, and 20 seconds respectively. Their time of burning is subject to considerable variation, according to the quality of the ingredients and the manipulation in mixing them; the exact proportions must be determined by experiment. The composition is carefully mixed, and several fuses are first driven and their times of burning determined, and the proportions varied, if necessary, to produce the required result.

The following utensils are required for driving the fuses: *brass molds* in two parts, which are held together by a wedge or cam; the molds have holes for four or five fuses; *steel drifts*, .35 inch diameter; *knife; mallet*, weighing ½ pound.

The mold is put together and secured; the empty cases are inserted and driven gently in; their upper ends, projecting above the mold, are slit with a knife into four parts. The composition is put in and driven as described above, giving 15 blows to each ladleful, which will make .25 inch in length of the fuse. They are next primed by covering the larger ends with shellac varnish and dipping them into rifle-powder; when the priming has set, the entire fuse, except the priming, receives a coat of shellac varnish. The fuse is stained the proper color, according to the composition used, and the number of seconds that one inch will burn is marked on each fuse.

To cut the fuse it is inserted in an iron gauge, the bore of which is the same size and taper as the fuse, and its width is the true length of the fuse—2 inches. The projecting ends of the fuse are first sawed off with a fine saw and then trimmed with a knife. They are packed in wooden blocks (poplar), bored to receive five fuses each, and these blocks are wrapped in various-colored paper, to distinguish the different times of burning, having a printed label setting forth the kind of fuse, and place and date of manufacture, etc.

The fuses are applied to projectiles by inserting them in wood or metal plugs, which are driven or screwed into the fuse-hole of the projectile. For sea-coast service, the paper-case time-fuse is inserted in a metallic plug fitting the projectile. The metallic plug is fitted with a screw-cap, called a water-cap, having a crooked passage, through which, by suitable priming,



flame is communicated to the fuse, and the escaping gases are intended to exert sufficient pressure to prevent the entrance of water to extinguish the fuse, especially with spherical projectiles. The insertion of the fuse in the rear end of the rifle-projectile has been proposed to dispense with the use of the water-cap, but the enormous force exerted upon the projectile, while in the gun, has been a serious obstacle to the practical use of a rear fuse.

Fuses for Smooth-bore Field-guns and Mountain-howitzers.—A fuse for shells and spherical case-shot for field and mountain service is that known as the "Bormann fuse." It consists of a circular disk of soft metal, containing an annular space charged with mealed powder. The outer circumference of the disk is chased with the threads of a screw to secure it in the shell. The annular space for the composition is concentric with the outer circumference, and connects at one end by a hole with a small magazine in the center of the disk, filled with rifle-powder, and closed on the under surface by a thin disk of tin. The fuse is charged from the under side by pressure, and a ring of the same metal is pressed firmly on the composition. The composition is thus securely protected from accidents, and the fuse is screwed into the shell in the laboratory. The metal covering the composition on top, being left thin, is easily cut with a knife or cutter at the moment of loading, and the composition exposed at the required point to the action of the flame. The graduations into seconds and quarter-seconds are marked on the upper surface of the disk. The time of burning of the whole length of fuse is 5 seconds.

The following utensils are required for casting the fuse: *molds* for the fuse; *molds* for the ring; *hacksaw; nippers; mallet; kettle; ladle.*

Melt the lead and tin together; heat the molds so as not to chill the metal in casting. Fill the mold with the melted metal, and tap it gently with the mallet to make the metal fill the small parts. Cut off the gate with the saw, and the ends of the ring with the nippers. It has been found convenient in opening and closing the molds to attach the two parts of the mold for the fuse and also for the ring to the jaws of a bench-vise, so that both molds are opened and closed by the same movement of the screw. The fuse-mold is kept hot by means of iron disks, which are heated and hung on the arbor which supports the molds. A mold of more approved pattern has been devised by which the casting is expedited.

The following utensils are required for charging the fuse: a strong *screw-press; annular charger* the size of the ring; *annular drift; flat drift; round drift.*

Take the mold in which the fuse was cast, place the fuse in the parts of the mold containing the screw and the upper or graduated side, and secure the mold by a ring driven on it. Draw up the piston, and fill the charger by pressing it into the mealed powder contained in a shallow pan; place the charger over the groove and force down the piston, transferring the powder into the fuse; insert the button in the magazine and the pin in the priming-hole to preserve their shapes; place the ring on the powder, and, with the annular drift, force it down by means of a strong screw-press, bringing the ring flush with the surface of the fuse; rivet the ring in its place with another drift; withdraw the button and the pin, charge the priming-hole with rifle-powder, and fill the magazine with musket-powder; cover the magazine with a disk of tin, and rivet it in place by means of, first, a flat drift, and then a round one, which turns down a part of the metal of the fuse over the disk. Remove the fuse from the mold, place it in a screw-chuck made to fit it, and turn off in a lathe the lower surface smooth and to the proper thickness. The powder of the fuse is now perfectly sealed up from the air. The fuse should be varnished.

The following table shows the principal dimensions and weights of the service-fuses:

Dimensions and Weights.				Wooden Fuses.			Paper Fuses.
				13 inch.	10-inch.	8-inch.	
Fuse	Whole length		inches	10.8	9.4	6.3	2
	Diameter	At top	do.	1.85	1.7	1.25	.53
		At bottom	do.	1.25	1	.9	.4
		Of bore	do.	.4	.3	.3	.35
First cone	Length		do.	2.8	2 25	1.25	....
	Diameter at lower end		do.	1.65	1.55	1.15	....
Cup	Depth		do.	.6	.5	.4	....
	Diameter	At top	do.	1.25	1	.75	....
		At bottom	do.	.9	.8	.6	....
Thickness of wood at bottom of fuse			do.	1.2	.9	.9	....
Length of composition			do.	9	8	5	2
Drifts	Diameter		do.	36	.27	.27	.3
	Length, exclusive of handle	First	do.	9	8	8	....
		Second	do.	4.5	4	4	....
Weight	Of composition for 100 fuses		pounds	8	4	2.5	2
	Of 100 fuses complete		do.	54	33	16	....
Paper for the case	Whole length		inches	....	....	....	19
	Length of rectangle		do.	....	....	....	6
	Width of rectangle		do.	....	....	....	2.25
	Width of small end		do.	....	....	....	.4

Bormann Fuse.

Diameter of fuse, including threads	1.65 inch.
Thickness	.45 incb.
Number of threads to the inch	12
Diameter of plug, including threads	1.07 inch.
Thickness for field-guns	.3 inch.
Number of threads to the inch	12

PERCUSSION-FUSES.—Many varieties of fuses have been used in service, under the names of percussion and concussion fuses. Among the simpler ones, the Absterdam, Hotchkiss, Parrott, and Schenkl may be named. They are much alike in their general features. They consist of hollow metallic screw-plugs to fit the fuse-hole of the projectiles. A loosely fitting plunger is inserted in the bore of the plug, the front end of which is closed by a screw-plug or cap. On the forward end of the plunger a percussion-cap, or rather detonating device, is arranged, to be exploded and communicate fire to the bursting-charge, through an opening at the rear, by the plunger striking the plug or cap when the motion of the projectile is arrested. Various safety devices are used, having sufficient strength to prevent the plunger being thrown forward by shocks in transportation, etc., but weak enough to be broken by the shock of discharge, or impact of the projectile, as the case may be.

COMBINATION FUSES.—Many varieties of combination-fuses have been proposed and tested, but without satisfactory results. This variety of fuse would be best adapted to general service if perfected. If a perfect combination-fuse can be made, none other would be required, as it would have the properties of the other two, capable of use separately or combined. Granting certainty of ignition of the time element, only one kind of fuse would be required for all kinds of service. A good one should possess, in one structure, the properties of the most perfect time- and impact-fuses. It should be simple in construction, safe to handle and transport, and easily applied to the projectile.

It is the opinion of many who have given the subject much study that no fulminate or friction composition should enter into its construction, except perhaps to insure the ignition of the time element of the combination. Certainty of ignition by the gases in the gun is not always attainable, especially with rifle-projectiles and breech-loading cannon which have but slight windage; therefore some form of inertia igniter is necessary. Such igniters are simple and easily made, and may be arranged for attachment to the fuse at the last moment before loading the gun, thereby avoiding all risk of accident in transportation, etc. The above conditions exclude all but a few of the devices subjected to trial, and the subject is still unsettled and under test. No one variety of the many offered for test has given sufficiently satisfactory results to warrant its adoption.

It is impossible that any species of fuse should be absolutely perfect. When suitable opportunities for observation occur, it is noticed that in firing a number of shells many do not explode. The failure of the composition to ignite is probably generally due to the absorption of moisture; and therefore all fuses which have been more than one year in service should be returned to the laboratory. Fuses of over two years' date of manufacture should not be issued for service. Sometimes the fuse is extinguished after having been ignited. This may occur when the shell ricochets on soil or water. Water is not so detrimental as sand, and the fuse is rarely extinguished by several ricochets upon it. Generally the gases evolved by the combustion of the composition will repel with great energy any obtrusive matter which would extinguish the fuse if once in contact with the ignited surface.

Premature explosions may be caused by the increase of the ignited surface of the composition resulting from cracks in the case or composition itself, or by interstices between the case and composition; and in proportion to the extent of this cause so will be the increased celerity of the combustion. Crevices may occur in the composition from some defect in the tools or in the mode of using them, or they may be created by bending the case. It may also happen that the displacement of the shell by the charge of the gun will force in the column of composition or the case with it. This would of course cause the shell to explode very quickly. The shell may be defective in thickness or quality of metal, and be crushed by the force of the discharge, when the explosion will take place in or near the gun. The bursting of the shell near the muzzle of the gun is sometimes attributed to the detonating qualities of the powder in the shell. It is manifest that the premature explosion of shells is far more detrimental to their efficiency than the failure to be exploded at all. See *Abstrdam Percussion-fuse, Bormann Fuse, Boxer Fuse, Concussion-fuse, Detonating-fuse, Dynamo-electric Igniter, Eggo Percussion-fuse, Electric Fuses, Fire-works, German Percussion-fuse, German Time-fuse, Gill Combination-fuses, Hotchkiss Percussion-fuse, Lissberger Fuses, McIntire Fuses, Mortar-fuse, O'Reilly Combination-fuse, Percussion-fuse, Pettman Fuse, Plumacher Percussion-fuse, Royal Laboratory-fuse, Ruben and Fornerod Combination fuses, Running-fuse, Schenkl Percussion-fuse, Seacoast-fuse, Splingard Fuse, Thompson Combination-fuse, Time-fuse, Treadwell Combination-fuse*, and *Ware Combination-fuses.*

FUSE-AUGER.—An instrument for regulating the time of burning of a fuse by removing a certain portion of the composition. It consists of a steel bit, fastened into a wooden handle, at the lower end of which is a brass socket, with a bar, under which a graduated limb of the slider moves. The bit fits into the slider, and is by a steel thumb-screw fastened to it in any required position. The position of the slider, which determines the depth to which the auger bores, is regulated by a fine scale attached to it by a screw.

FUSE BLOCK.—A simple contrivance for holding paper time-fuses when being cut. It consists of two blocks of wood hinged together so as to open and shut after the manner of a book. In each end is a recess into which the fuse is placed, and where it is securely held by pressing the blocks tightly together. The fuse is put in with the small end extending out of the end of the block, the point at which it is to be cut being even with the end of the block.

Along one side of the recess is attached the brass scale. This was intended for fuses of obsolete pattern. As now made, each fuse is divided into as many equal parts as the number of seconds for which its entire length (two inches) is intended to burn. These parts are marked, and are the guides in cutting the fuse; the latter operation being performed with the *fuse-knife*, which is a very sharp and thin-bladed knife (preferably a shoe-knife), or a fine saw.

FUSE-ENGINE.—A name formerly given to an instrument for extracting a wood fuse when fixed in a spherical shell. As it was found faulty in construction it has been replaced by the present fuse-extractor, which is applicable to extracting wood fuses from rifled shells.

FUSE-EXTRACTOR.—An implement used for extracting wooden fuses from the fuse-hole, when they have been too firmly driven to be withdrawn by the *shell plug-screw*, or in any other way. It consists of an inner screw and stem of steel, riveted to an iron handle, and contained in a hollow steel screw, which works up and down by means of an iron nut with two handles. The hollow screw is prevented from turning by a slot and a feather in the frame, which is of brass. The nut is kept in place by four iron set-screws, the points of which enter into a groove in the nut. To extract a fuse, the bottom of the frame is placed on the shell over the fuse-head, and the inner screw screwed into the fuse by means of the upper handle. The handles of the nut are then turned, which raises the hollow screw, and with it the inner screw and the fuse.

FUSE HOLE.—The hole in a shell prepared for the reception of the fuse-stock. The loss of force by the fuse-hole may be ascertained with sufficient accuracy, provided we know from an actual experiment the amount of the loss from the fuse-hole of any one shell.

Let R and r be the exterior and interior radii of a spherical projectile; T, the tenacity of the metal; i, the radius of the fuse-hole; w', the weight of powder necessary to burst it under the supposition that there is no loss of force at the fuse-hole; w, the weight of powder that is actually required to burst it. By formulas approved we obtain the value of w'; $w - w'$ is therefore the amount of loss from the fuse-hole. Take another projectile, and let w_1' represent the charge which is necessary to burst it, under the supposition that there is no loss, and w_1 the weight that is found by experiment necessary to burst it; $w - w_1'$ will represent the loss. We are at liberty to suppose the loss from the two fuse-holes is proportional to the size of the holes, and the density of the gases at the moment of rupture; we shall therefore have this proportion:

$$w - w' : w_{,} - w_{,}' :: i^2 d : i_{,}^2 d_{,}.$$

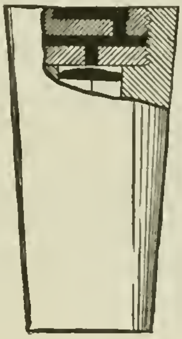
Or,

$$w = w' + (w_{,} - w_{,}')\frac{i^2 d}{i_{,}^2 d_{,}}.$$

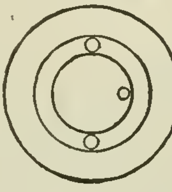
From the experiments made at Metz in 1835, it was shown that this mode of estimating the loss of force by the fuse-hole was sufficiently accurate for practical purposes. See *Bouching* and *Shells*.

FUSE-MALLET. — An implement for setting the fuse home. It is cylindrical in shape, with a handle on one end, and is turned out of a single piece of dog-wood, oak, or other hard wood.

FUSE-PLUG.—Fuse-plugs are made of brass or of close-grained wood, well seasoned. They are turned to a size a little larger than the fuse-hole, but of the same taper,—2.5 inches long; a hole is bored through the axis and reamed out to receive the paper fuse, and the large end is counterbored and tapped to receive the water-cap. If a wooden plug be used, a short, hollow cylinder of brass, .5 inch long, .15 inch thick, is inserted in the recess before the plug is driven, and afterwards tapped to receive the water-cap.



The *water-cap*, shown in the drawing, is a plug of brass, .5 inch long, .6 inch in diameter, chased with 12 threads to the inch. One end has a shallow recess cut in it, .1 inch deep, larger at bottom than at top; a hole .1 inch in diameter is bored through the middle of the cap, and a hole is bored from either end into this transverse hole, but meeting it at points .25 inch or more apart; these and the recess in the end are filled with mealed-powder paste. Diameter of hole at bottom of recess, .53 inch; at small end, .4 inch.



A little shellac is brushed around the safety-plug and lower end of fuse-plug; also around the leaden patch and top of stock. A pasteboard cap is put on over the safety-plug end of the fuse-plug to prevent the plug from being broken off, and the fuses thus prepared are stowed in boxes. See *Fuse* and *Water-cap*.

FUSE-REAMER.—The implement used to enlarge the hole in a fuse-plug so as to make it of the proper size for the paper fuse.

FUSE-SETTER.—An implement for setting wooden fuses in the fuse-hole. It is made of brass; the bottom is countersunk and cup-shaped, to prevent it from slipping off from the head of the fuse.

FUSE-WRENCH. — A three-pronged wrench used for setting fuse-plugs that are to be screwed into the shell. One prong contains forks for the fuse-plug, and another one smaller forks for the water-cap.

FUSIBLE METAL.—Fusible metal is composed of 2 parts of bismuth, 1 of lead, and 1 of tin. It fuses at 201° F., becoming pasty before it completely melts. It expands in a very anomalous manner; its bulk increases regularly from 32° to 95°; it then contracts gradually to 131°; it then expands rapidly till it reaches 176°, and from that point till it melts its expansion is uniform. The faculty of expanding as it cools, while still in a comparatively soft state, renders the alloy very serviceable to the die-sinker, who employs it to test the accuracy of his die, every line being faithfully produced in the cast made of the alloy. The proportions of the three metals are sometimes varied, and another formula is given in the table in FUSING AND FREEZING POINTS.

FUSIL.—1. A firelock lighter than the musket, invented in France about 1635, and deriving its name from the Italian word *focile*, "a flint." In 1678 a British regiment was armed with the fusil, and the King added a company of men armed with hand-grenades to each of the old British regiments, which was designated the Grenadier Company.

2. *Fusil* is represented heraldically as longer and more acute than a lozenge.

FUSIL A CHEVALETS.—A species of fusils upon rests, which was recommended by Marshal Vauban to be used at the commencement of a siege, about 50 or 100 toises in front of the glacis, at the entrances of narrow passages, etc.

FUSILIER.—Formerly a soldier armed with a shorter and lighter musket than the rest of the army, which he could sling over his shoulder. The fusilier regiments, of which there are ten in the British service, are not distinguished from the Infantry of the Line as they formerly were; the title is now purely honorary, and they are armed and dressed in every way like the line regiments, except in the head-dress and the mode of wearing their chevrons. The head-dress of the officers is a busby, the material of which is made of raccoon-skin, for that of the non-commissioned officers and of the men, of seal-skin. On parade, or marching in quick time, or upon occasions of guard-mounting parade, or review, they always march to the Grenadiers' March.

FUSILLADE.—The simultaneous discharge of firearms in various military exercises.

FUSIL-MOUSQUET.—A name applied to the *flint-lock* gun, invented about 1640, and introduced into the French army by Vauban. This gun had a bayonet with a socket.

FUSIL-RAYE.—The name given to the early long-range rifle of the Imperial Guard.

FUSILS A L'EPPE.—Fusils with long bayonets, shaped like a cut-and-thrust sword. These weapons were recommended as extremely useful in the rear rank of a battalion, or in detached bodies that are stationed for the defense of baggage, etc.

FUSING AND FREEZING POINTS. — Terms applied to the temperature at which solids assume the liquid form and liquids become solid. The following table gives some of the best determinations of the fusing-point:

Mercury	−39°
Oil of vitriol	−30°
Bromine	9°.5
Oil of turpentine	14°
Ice	32°
Lard	91°
Phosphorus	111°.5
Potassium	136°
Yellow wax	143°.6
Stearic acid	158°
Sodium	207°.7
Fusible metal (5Pb,3Sn,8Bi)	212°
Iodine	226°.4
Sulphur	239°
Alloy (1Sn,2Bi)	286°
" (3Sn,2Pb)	333°
Tin	451°
Bismuth	512°
Nitrate of soda	591°
Lead	620°
Nitrate of potash	642°
Zinc	773°
Antimony (about)	900°
Silver	1773°
Copper	1996°
Gold	2016°
Cast-iron	2786°
Wrought-iron, higher than	3280°

We see from this table that alloys may have a fusing-point far below that of any of the metals which enter into their composition. Similarly, mixtures of various silicates fuse at a temperature far below that which is required to melt any one of them, and the same remark applies to mixtures of various chlorides, carbonates, etc.

Most solids, when heated to their fusing-points, change at once into perfect liquids; but some—as, for example, platinum, iron, glass, phosphoric acid, the resins, and many others—pass through an intermediate pasty condition before they attain perfect fluidity, and, in these cases, it is difficult, if not impossible, to determine the exact fusing-point. This intermediate condition is termed *vitreous fusion*, because it is a characteristic property of glass. It is in this intermediate state that glass is worked, and iron and platinum forged.

As a general rule, the freezing-point is the same as the fusing-point—that is to say, if a substance in the liquid form be cooled below the fusing-point, it again becomes solid; but there are cases in which we can cool a liquid several degrees below its fusing-point; thus, by keeping water perfectly still, we can cool it to 5°, or even to 1°.4, before it freezes. If, however, we drop a solid body into water in this condition, or if we shake the vessel containing it, congelation begins at once, and the temperature rises to 32°. This phenomenon is exhibited to a still greater degree in viscid fluids, like the oils. It is well known that the freezing-point of water is depressed by the presence of salts. Thus, sea-water freezes at about 26°.6, and a saturated solution of common salt must be cooled as low as 4° before freezing.

FUSS-STREITAXT.—A German battle-axe, having a long handle and used by the foot-soldiers.

FUST — FUSTAGE. — The very early gun-carriage, upon which the ancient bombard was fixed by means of iron work. These carriages consisted of blocks of wood or frame structures, made in imitation of the mountings of small-arms.

FUSTIBALE.—A kind of sling with a handle fastened to it. It was used as late as the sixteenth century for hurling fireballs and grenades.

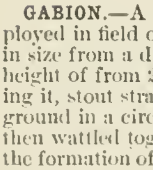
FUSTUARIUM.—In Roman antiquity, a method of inflicting capital punishment upon any soldier guilty of theft, desertion, or similar crimes. When the accused had been found guilty, he was made to stand in front of the legion to which he belonged. One of the Tribunes then touched him lightly with a stick, and all the soldiers immediately rushed upon the criminal and beat him to death with clubs (fustes). If he escaped—as he was allowed to do if he could, but which was rarely if ever possible—he was forbidden ever to return to his native country, and his nearest relatives were not allowed to receive him into their homes or houses. This method of capital punishment continued to be enforced even under the Empire.

FUTCHELLS.—Horizontal longitudinal bars which rigidly connect the splinter-bar with the axletree-bed, or with springs or other intermediate connection between them and the axletree.

FYROZ.—A Persian word signifying *victorious*, and forming the name of several ruling kings in Persia and Hindostan. Also written *Feroze.*

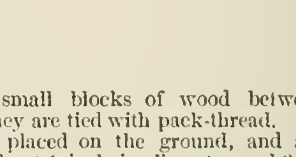
G

GABION.—A hollow cylinder of basket-work, employed in field or temporary fortification, and varying in size from a diameter of 20 inches to 6 feet, with a height of from 2 feet 9 inches to 6 feet. In constructing it, stout straight stakes are placed upright in the ground in a circle of the required diameter, and are then wattled together with osiers or green twigs, as in the formation of baskets. The apparatus being raised, when completed, from the ground, the ends are fastened, and the gabion is ready to be rolled to any place where it is desirable to form the breastwork against the enemy. Placed on end, and filled with earth, a single row of gabions is proof, except at the points of junction, against musketry-fire, and by increasing the number of rows any degree of security can be obtained. The gabion has the advantage of being highly portable, from its shape, while with its aid a parapet can be formed with far less earth, and therefore in less time, than in cases when allowance has to be made for the slopes on both sides, which are necessarily present in ordinary earthen walls. The *sap-roller* consists of two concentric gabions, one 4 feet, the other 2 feet 8 inches, in diameter, with the space between them wedged full of pickets of hard wood. In sapping, these serve as substitutes for mantlets. *Stuffed gabions* are gabions rammed full of broken branches and small wood; being light in weight, they are rolled before soldiers in the trenches, and afford some, though not a very efficient, protection against musketry-fire.



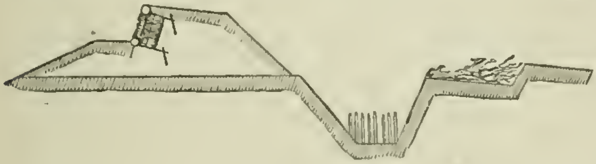
To form a gabion, a *directing circle* is made of two hoops, the difference between their radii being such that, when placed concentrically, there shall be about 1¾ inches between them. They are kept in this position by placing small blocks of wood between them, to which they are tied with pack-thread. The directing circle is placed on the ground, and seven or nine stakes, about 1 inch in diameter and 3 feet long, are driven slightly into the ground between the hoops, at equal distances apart; the directing circle is then slipped up midway from the bottom, and tied in that position. Twigs about half an inch in diameter, and as long as they can be procured, are wattled between the stakes like ordinary basket-work: when finished within about 1½ inches of the top, the gabion is placed with the other end up, the directing circle is taken off, and the gabion is completed within the same distance from the other extremities of the pickets. The wicker-work at the two ends is secured by several withes, and the ends of the pickets being brought to a point, the gabion is ready for use. See *Gabion Revetment, Jones Gabion,* and *Tyler Gabion.*

GABIONADE.—Traverses placed between guns or on their flanks to cover them from an enfilade-fire are usually termed *gabionades*. To form a gabionade, gabions are placed in a row, side by side, inclosing a



rectangular space of about 15 feet in width from out to out, and about 24 feet in length, perpendicular to the parapet. A second row is placed within this and touching it, and a third row inside of the second. The area thus inclosed is filled in with earth to a level with the top of the gabions. Six rows of large fascines are next laid on the gabions to support a second tier consisting of two rows. The second tier is filled in like the first, and the earth is heaped up on top. Four rows of large fascines are placed on these to support a third consisting of one row, making the gabionade nearly twelve feet high. The ends are inclosed by filling in with gabions, as for the sides. A passage-way of about two feet is left between the end of the traverse and the parapet. This space may be roofed over with logs and earth to form a cover in which the cannoneers may shelter themselves against fragments of shells. *Splinter-proof traverses* may be made by placing two thicknesses of gabions side by side filled with earth, with a second tier of one thickness on top. When a service-magazine is to be placed in a gabionade, the rows of gabions are set farther apart, and the excavation for the magazine is made between them. The chamber of the magazine is constructed in one of the ways heretofore described. A *parapet en gabionnade* is a parapet constructed of gabions. See *Traverse*.

GABION REVETMENT. — Gabion revetments are rarely used for the interior slopes of ordinary field-works. They are much and usefully employed in the trenches in siege-operations, in batteries, and in embrasures. When used as a revetment for the interior slope, they give a height of three feet, in consequence of the projecting ends of the pickets. They are made to rest upon a row of fascines half buried in the banquette, and are so placed as to have the same inclination as the interior slope. The gabions are then filled with earth, and the parapet is raised behind them. When the parapet reaches the height of the gabion, a row of fascines is laid on top of the gabions to give the requisite height to the interior crest.



Profile of Gabion and Fascine Work.

To form this revetment, a fascine is first laid partly embedded below the tread of the banquette; the gabion, which is placed on end, rests on this, so as to give it the requisite slope; it is then filled with earth; others are placed in like manner, and the parapet is raised behind them; another fascine is laid on top, and in some cases two. The drawing shows the profile of gabion and fascine work, with small pickets in the ditch, and an abatis behind the glacis. In making the gabions, iron hoops, similar to barrel-hoops, may be used instead of wattling. The number of stakes should be increased to eleven or thirteen. Gabions made either of wattlings or hoops are not good for holding dry sand. Sheet-iron is preferable to either iron hoops or brush for gabions. For this purpose rectangular sheets of suitable dimensions to form cylinders of the same height and diameter as the ordinary gabion are prepared, with three holes punched near to and parallel with the shorter sides of the sheets. These are to secure the ends with wire when the sheet is bent into the cylindrical form. The advantages of this description of gabion are greater strength, lightness, and durability than either of the other two, offering great facility for transportation, and resisting better the blast of guns when used for revetting the cheeks of embrasures. Galvanized iron is less liable to rust than plain iron; when not galvanized, the gabions should be always lacquered with coal-tar. See *Revetment*.

GABION TRIP.—The bands of Jones's iron gabions may be formed into a network as an obstacle against cavalry and even against infantry in night-attacks. The bands are buttoned and placed in line 3 or 4 feet apart; each band is then connected with the next by stout wire or rope passed through binding-holes. Bands thus connected should be laid in parallel rows, checkerwise, 3 or 4 feet apart, the rows also connected by wire or rope and secured at intervals to pickets driven into the ground. See *Gabion*.

GAD—GADLING.—An old Norman name given to that part of the gauntlet which covers the knuckle, and which was armed with knobs or spikes of iron. In a trial by combat adjudged between John de Visconti and Sir Thomas de la Marche, fought before Edward III. in close lists, at Westminster, Sir Thomas de la Marche gained the advantage by striking the gadlings of his gauntlet into the face of his adversary. The term *gad* is also applied to the point of a spear or an arrow-head, and the withe used in the construction of fascines.

GADARU.—The French term employed for a very broad Turkish saber, formerly in common use.

GAFFLES.—A name applied to the steel levers by means of which the ancients bent their cross-bows.

GAGE.—1. A pawn or pledge. The word is derived from the French *gager*. Hence, by changing *g* into *w*, we have *wage* and *wager;* as, "wager of law," "wager of battle," wherein a person gave his pledge that he would sustain his affirmation; and, in the latter case, the glove was sent as a material pledge to be redeemed by a mortal combat. Hence also in England.

2. A tool for setting out lines and grooves parallel with the margin of the carpenter's work. The "stem" of the gage is retained in the head or stock by means of a small wedge, and the cutter is fixed in a hole at right angles to the face of the stem by another wedge. There are several forms of gages, such as the *marking, cutting, router, mortise gage*, etc. See *Gauge*.

GAINE DE FLAMME.—A variety of linen sheath or cover into which the staff of a flag or pendant is put.

GAINE DE PAVILLON.—A cloth or linen band which is sewed across the flag, and through which the different ribbons are interlaced.

GAINING TWIST.—Some of the rifles and rifled ordnance in the service are made with grooves which have a very slight twist at the breech, but the twist is increased regularly until it reaches the muzzle; this is known as the *increasing* or *gaining twist*. At the instant of discharge, when the shot from a state of rest is instantly given a high velocity, it would seem likely to be pushed across the grooves, especially if they have a great inclination. To avoid this, the inclination of the grooves is made slight at the breech, and increased gradually toward the muzzle, at which point they are sufficiently inclined to give the necessary rotatory motion. In the increasing twist, though the projectile leaves the seat or chamber of the gun with great velocity, and relieves the breech a good deal from the strain of the discharge, its velocity is less than from a gun with *uniform twist*. See *Twist*.

GAIN-PAIN.—A term applied in the Middle Ages to the sword of a hired soldier.

GAITERS.—A sort of cover for the leg, usually made of cloth, and either long or short. Those reaching just above the ankle are termed *half-gaiters*, and are worn by infantry soldiers in Europe.

GALEA.—Among the Romans, a light casque, head-piece, or morion, coming down to the shoulders, and commonly of brass; though Camillus, according to Plutarch, ordered those of his army to be of iron, as being the stronger metal.

GALENA.—A mineral which is essentially a sulphuret of lead, the proportions being 13.3 sulphur and 86.7 lead; but usually containing a little silver, and sometimes copper, zinc, antimony, or selenium. It is of a lead-gray color, with a metallic luster, is found massive, or sometimes granular, or crystallized in cubes or octahedrons. It is very easily broken, and its fragments are cubical. It occurs in veins, beds, and embedded masses, often accompanying other metallic ores, in primitive and secondary rocks, but most of all in what is known as transition or mountain limestone. It is found very abundantly in some parts of Britain. Almost all the lead of commerce is obtained from it. It sometimes contains so much silver that the separation of that metal is profitably carried on. The lead is extracted from it by a very simple process. See *Lead*.

GALE'S COMPOUND.—Powdered glass with gunpowder, rendering the latter non-explosive; so named after the patentee.

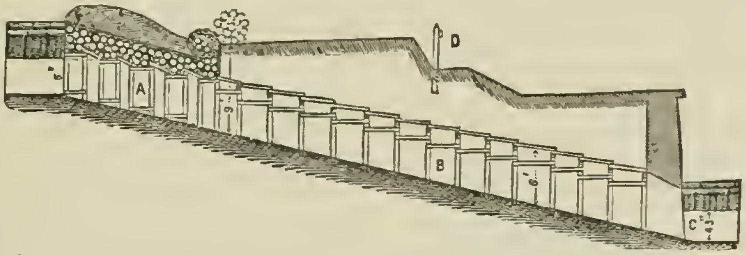
GALET.—The French name for the German *ballestre*, a cross-bow above the ordinary size. The term is also applied to a round stone thrown from a sling or bow, and is sometimes written *Gallet* and *Jalet*.

GALL.—The wound inflicted on draught or riding horses from the imperfect fitting of the harness or saddle. The slightest tendency to gall should be promptly looked after. Hot water and poultices make the best early treatment. Leather burned to a crisp and finely powdered, when spread over the wound, causes it to heal very quickly. There is no excuse for the frightful wounds on the backs of mules and horses due to improper saddling.

GALLAS.—A warlike race occupying the South and East of Abyssinia. The general name by which the tribes designate themselves is *Oroma* (*orma*, men). Although generally belonging to the negro race, they are not purely negroes, but form with the Fulahs, Mandingoes, and Nubas, as it were, the transition to the Semitic variety, and seem to belong to that great family inhabiting the East of Africa, from the frontiers of the Cape land to Abyssinia, and usually denominated the Kaffers. They are a vigorous, well-formed people of a dark brown color, with hair frizzled but not quite woolly, round faces, and small sharp eyes, and are distinguished not less by their energy and warlike spirit than by their mental capacities. They first appear in history in the sixteenth century, as a barbarous people, extending their conquests from the interior of Africa, laying waste, by constant incursions, the countries of Eastern Africa, to the mountains of Abyssinia, gradually subduing or expelling the original inhabitants (hence their name), occupying great part of Abyssinia, and advancing as far as the Red Sea and the Gulf of Aden. It is only of late years that their power in Abyssinia, and their incursions into that country, have been partially checked, chiefly by the vigorous government of the King of Shoa, who subdued some of the Gallas tribes and induced them to profess such Christianity as exists in Abyssinia. They still, however, occupy many districts of Abyssinia, and extend their power to an indefinite extent over the countries situated south and southwest of it. Politically, the Gallas do not form a single Nation, but are divided into numerous tribes, forming separate Kingdoms and States, which are frequently at war with each other. Most of the Gallas follow pastoral avocations. Some, however, through intercourse with the semi-Christian, semi-civilized Abyssinians, have become tillers of the soil. The wandering Gallas are mainly engaged in hunting and the slave-trade. The larger number of the Gallas are still heathens, though Mohammedanism has lately made great progress among them. Their religion bears a resemblance to that of the Kaffers.

GALLERY.—A covered passage cut through the earth or masonry in a fortification, either as a means of communication, or as a position whence a musketry-fire can be maintained through loopholes. For the latter purpose, galleries are formed occasionally in the counterscarps of dry ditches, where their defenders exercise a flanking fire upon the ditch. To explain the practical operations in driving a gallery, let an example be taken where the soil is loose, and the floor of the gallery rises from the point of departure. In this case the first frame of the gallery must be set up within the shaft and against the shaft-frames, on the side from which the gallery is to open. The ground-sill of this frame being laid, the stanchions are secured to the intermediate shaft-frames of the last interval by battens, and the top sill fastened. A horizontal beam is then secured to the under side of the top shaft-frame of the same interval, to preserve the proper slope for the top sheeting when inserted; wedges being placed between this beam and the sheeting-board for this purpose. A like arrangement for the side sheeting may be made if necessary. The excavation of the gallery is now commenced at top, by forcing down with a crowbar the sheeting of the shaft on the side of the gallery. The earth is removed gradually forwards and downwards, and the gallery-sheeting advanced at the same rate. When the excavation has reached as low as the intermediate shaft-frame, the piece of it that sustains the lower portion of the sheeting is removed to allow the excavation to proceed. When in this way the earth is removed as far as the middle of the first interval, the auxiliary gallery-frame is set up, to support the top and side sheeting until the second gallery-frame is placed. To place this last frame, the position of the ground-sill is first determined by placing the slope-block on the ground-sill first laid, and then, by a common mason's level upon the side of which the interval is marked, laid upon the slope-block, bringing the top of the ground-sill on the same level as that of the slope-block. The sill being adjusted and firmly secured, the stanchions are next set up, and secured by battens to the stanchions of the first frame, and the cap-sill is secured in the last place. The adjustments of the stanchions and cap-sills are made by an ordinary plumb line, by means of which the edges of the stanchions are placed vertically, and the scores on the cap- and ground-sills brought into the vertical plane of the axis of the gallery. The battens are placed horizontally. In a level gallery they are nailed alternately at 4 and 8 inches below the cap-sill. In others they are nailed 4 inches below the lower of the cap-sills of the two frames which they unite; this will bring them to 4 inches, added to the height of the slope-block, below the other. The auxiliary frame is not taken down until wedges have been placed between the sheeting and the frame last placed, in order to introduce the boards for the next interval; and these last are kept in the proper direction, as the excavation is advanced, by wedges inserted between them and the sheeting of the interval finished. See *Auxiliary Frame*, *Branch Galleries with Dutch Cases*, *Gallery Descent*, *Gallery Intervals*, *Scarp-gallery Shaft*, *Slope-block*, and *Wooden Gallery*.

GALLERY DESCENT.—A descent to a ditch is usually by blindage when the depth of the ditch does not exceed 10 or 12 feet. For greater depths the commencement of the descent is by a blindage which is continued to a point where the bottom of the descent is about 9 feet below the surface of the ground; here the blindage is terminated, and the remainder of the descent is made by gallery, as the depth of the earth above the gallery will be sufficient to allow the excavation to be carried on without trouble. In a firm soil, grand gallery-frames are used for the descent; in a loose soil, common gallery-frames. The frames used and construction of the gallery are the same as for a mine-gallery. The point of departure of a ditch descent is usually taken at only about 2 feet below the bottom of the trench; the usual landing being made at this point. In a dry ditch, the bottom of the descent should come out at the usual depth of the full sap below the bottom of the ditch. In a wet ditch it should come out about 15 inches above the water-level. The passage of a dry ditch is nothing more than a full sap, which leads from the outlet of the descent in the ditch to the bottom of the breach. From this point the trench and parapet are directed up the breach to the scarp-wall, which forms the side of the breach towards the dangerous point. The only precaution necessary in making this passage is to sink the trench at the outset to its full depth of 43 inches to gain secure cover. The passage of a wet ditch is a perilous and difficult operation under any circumstances, but particularly so when a strong current can be produced, by the besieged, in the ditch. The methods usually recommended are to form a dike, or bridge of fascines and hurdles, laid in successive layers, and firmly connected by pickets. To form a footing for the dike, a grand gallery is excavated, directly behind the counterscarp-wall, to a distance of 12 or 15 feet on each side of the descent, and the earth from it is thrown into the ditch, through the outlet of the descent. The dike or bridge of fascines is gradually pushed forward from this point, being secured in the best way practicable to the earth thrown into the ditch. The sappers who carry forward the head of the dike are covered from the fire of the dangerous point by a musket-proof mask of fascines and boards, attached to a raft on which they work. The dike should be from 12 to 15 feet wide at top. A gabionade parapet, formed of two tiers of gabions filled with earth, is placed on it towards the dangerous side. The bottom tier consists of two rows of gabions, each crowned with two fascines, the two rows being in juxtaposition; the top tier is a single row crowned with three fascines. The top of the dike is covered by a layer of earth, and the parapet with raw hides, to prevent the effects of incendiary compositions that might be thrown on them. Raft-bridges, on barrels, protected by a gabionade parapet, have also been proposed, particularly where a strong current is to be contended with. See *Gallery*.



Longitudinal Section of Blinded and Gallery Descent into Ditch. A, Blindage-frames; B, Gallery; C, Passage of Ditch; D, Covered-way.

GALLERY INTERVALS.—The portion of the floor of the gallery between the frames that bound the entrance to a return is termed a *landing*. The landing is in all cases horizontal, as well as that portion of an oblique return between the oblique frame and the one next succeeding, which last should not be placed farther than an ordinary interval from the farthest point of the oblique frame.

Having determined, by means of the working sketch, the landings and their frames, with respect to the points of intersection of the axis of the gallery of departure with those of the returns, the intervals of this gallery can be calculated, and their positions marked out on the sketch. The manner of making this estimate will be best illustrated by observing the following example:

Let A B = 118 feet be the total length of a gallery of departure, estimated horizontally along its axis, from the central picket of the shaft from which the gallery starts. At the point C, 44 feet from A, the axis of a rectangular return commences; and at D, 44 feet farther, that of an oblique one. The part A C of the gallery is to be a common great gallery, the part C D a common gallery, and the portion D B a great branch. With these data it is required to determine the intervals for the different portions of the gallery.

To find the interval for the first portion, A C, subtract from the total distance, 44 feet, the following aggregate:

Half the width of the shaft in the clear. ..	2 ft. 2 in.
The thickness of the lowest shaft-frame...	4½ "
Half the width of the landing at C.......	2 " ½ "
Thickness of a gallery-frame at the landing	5 "
	5 ft.

Which leaves 39 feet to be divided into suitable intervals; which may be done by constructing twelve of them each 3 feet 3 inches.

The intervals of the portion C D will be found as follows. From 44 feet take the following sum:

Half the width of the landing at C......	2 ft. ½ in.
Thickness of the landing-frame.........	5 "
The distance from D (as found from sketch) to the landing-frame back.....	9 "
Thickness of gallery-frame at landing D.	4½ "
	3 ft. 7 in.

Which leaves 40 feet 5 inches. This can be divided into nine intervals, each 3 feet 1 inch, and four of 3 feet 2 inches each.

To find the intervals for the part D B, from 30 feet take the following aggregate:

Distance from D to frame of landing beyond it..................................	4 ft. 5 in.
Thickness of landing-frame beyond D....	3½ "
Thickness of last frame at B.......	3½ "
	5 ft.

This leaves 25 feet, which can be divided into six intervals of 3 feet 2 inches each, and two of 3 feet. See *Gallery*.

GALLERY TARGET-PRACTICE.—The method of using round balls and reduced charges in the service cartridge-shells solves practically and satisfactorily in many respects the question of unlimited target-practice. For this practice the targets are reduced directly as the ranges. The balls should be of sufficient diameter to slug in the rifling of the bore, and fit closely over the powder in the bottom of the shell. Any motion of the ball in the shell would vary the position the powder takes when poured in, and gives uncertain shooting. There is less fouling of the gun-barrel when the balls are slightly lubricated with Japan wax, paraffine, or some lubricant that solidifies in cooling, as distinguished from oils that remain liquid. Good results have been obtained by melting Japan wax, immersing the balls in it, and shaking off the excess of the lubricant in a sieve. In firing 100 rounds with ball lubricated, the weight of fouling was 50 grains, without lubricant 150 grains. When no lubricant is at hand, wiping out the bore after every 5 or 10 rounds, and then running a slightly oiled rag through it, will answer. The firing is more accurate when the shells and gun are cleaned after every 5 or 10 rounds; the shells washed in warm water, and the bore of the gun wiped out by pushing a wet rag through it, and afterwards an oiled one. The endurance of the Frankford, Lowell, and Winchester shells is from 200 to 300 rounds fired with round balls and small charges. They give out by the bottom of the pockets getting knocked in by repeated blows of firing-pin, which causes the primers to miss fire. When short of shells, the expedient could be resorted to of putting a thin disk of metal in the bottom of the pocket, with a vent hole in the middle, until the bottom of the pocket is entirely knocked through. Charges of 3, 4, and 5 grains of Oriental standard musket-powder give good accuracy at 50, 75, and 100 feet respectively, firing from a shoulder- and muzzle-rest. A wooden drift, with shoulder to prevent the ball from being driven in too tightly, is convenient. When any shell becomes expanded so as to fit the chamber of the gun tightly, it can be re-sized in the resizing die accompanying the reloading tools. This will not often happen. The penetration of round ball with 5 grains powder at 50 feet is about 1 inch in white pine, and slightly more in hemlock. A board from 2 to 4 inches thick is soon cut through by the balls. A box or barrel filled with dirt and placed in rear of target will catch the spent lead and prevent injury to the gallery. A butt made larger and filled with earth or sand will afford a better protection. If the balls are fired into and lodged in thick wood, difficulty will be experienced in digging them out. An iron screen would cause the balls to splash and rebound about the target; hence earth would seem to be best to fire into. The above gives some idea as to what should be done to prevent the gallery from being defaced and persons being injured standing near the target for scoring shots. A pound of powder furnishes 1400 five-grain charges, a pound of lead 50 balls. The lead can be recast as long as it lasts, taking care that it is not burned in remelting. Fifty shells will answer for 10,000 rounds at 200 rounds each, requiring 10,000 primers for reloading. With 50 men to a company, 10,000 primers, 50 shells, 40 pounds of lead, and 7 pounds of powder will give 200 rounds per man, assuming that the balls can be remelted and recast four times before the lead is entirely consumed. Friction in shooting wears away the lead. It appears evident that by the use of the round ball with reduced charges in the service-rifle the recruit may more readily than otherwise be taught to hold his gun with steadiness, pull trigger without deranging his aim, and overcome a very natural tendency to shut his eyes and shrink from the recoil of his piece at the moment of its discharge, while the trained soldier may thereby conveniently and economically preserve and improve that accord between the brain and the muscles without which the best marksmanship is impossible. See *Target-practice*.

GALLIC SWORD.—This sword was made of bronze. It was long, sharp-pointed, edged on both sides, and in the graceful curves of its form it somewhat resembled the leaf of the sage-plant. The weapon was like the Greek sword in general appearance.

GALLING FIRE.—The sustained discharge of cannon or small-arms, which by its execution greatly annoys the enemy.

GALLIVATS.—Large row-boats, formerly and still to some extent used in Eastern waters. They rarely exceed seventy tons, carry two masts with high triangular sails, and are generally armed with a few small swivel-guns, fastened on the bulwarks. The Malay pirates employ these swift but rather fragile vessels.

GALLOP.—The word of command in the School of the Soldier Mounted, by which the trooper is directed to cause his horse to lift alternately the fore-feet and the hind-feet together, in successive leaps or bounds. The horse gallops on the *right foot* when the right fore and hind legs move in advance of the left fore and hind legs; he gallops on the *left foot* when the left fore and hind legs are in advance. He gallops *true* when he gallops on the right foot in marching to the right hand, or on the left foot in marching to the left hand; and gallops *false* if, in marching to the right hand, he gallops on the left foot, or conversely. A horse is *disunited* when he gallops with the near fore-leg followed by the off hind-leg, or the off fore-leg followed by the near hind-leg; in either case his center of gravity is deranged, and his strength impaired. When the horse gallops on the left foot the rider feels a sensible movement in his position from left to right; when he gallops on the right foot the movement of the rider is from right to left; when the horse is disunited the rider experiences irregular movements. To cause the horse to gallop, gather him and keep him perfectly straight; carry the hand slightly forward, and to the left, to enable the right shoulder to move in advance of the left; close the legs behind the girth so as to urge the horse forward, causing him to feel the left leg most. When the horse obeys, keep the hand light that the gallop may be free and regular, and hold the legs close to keep him at the gait. To keep a horse true the rider must accommodate himself to all his motions, particularly in changing direction.

GALLOPER.—A carriage on which very small guns are conveyed, having shafts on which the gun may be borne without a limber. This carriage is seldom or never used in late years.

GALLOPER-GUNS.—Light guns of small caliber. Formerly these guns were attached to English infantry regiments, but they have long been abolished.

GALLOWGLASS.—In ancient times, a heavy-armed foot-soldier of Ireland and the Western Isles.

GALVANISM.—That branch of the science of electricity which treats of the electric currents arising from chemical action, more particularly from that attending the dissolution of metals. It is sometimes called dynamical electricity, because it deals with current electricity, or electricity in motion, and is thus distinguished from frictional electricity, which is called statical in consequence of its investigating the electric condition of bodies in which electricity remains insulated or stationary. These terms, although in the main thus properly applied, are in all strictness applicable to both sciences. Frictional electricity, though small in quantity, can pass in a sensible current, and galvanic electricity, though small in tension, can be made to manifest the attractions and repulsions of stationary electricity. Thus the series of discharges which are transmitted in a wire connecting the prime conductor of a machine in action with the ground possesses, though feebly, the characteristics of a galvanic current; and the insulated poles of a many-celled galvanic battery manifest before the current begins the electric tension of the friction-machine. The other branches of current electricity will be found under INDUCTION OF ELECTRIC CURRENTS, MAGNETO-ELECTRICITY, and THERMO-ELECTRICITY. The science of galvanism dates from the close of the eighteenth century. In the year 1780, Galvani, in making investigations on the nervous irritability of cold-blooded animals, discovered by accident that the limbs of a recently killed frog, when hung by the crural nerve on a metal support near an electric machine, contracted convulsively at the recurrence of each spark. This he properly accounted for by the back-stroke. Six years afterwards, in experimenting on atmospheric electricity with frog limbs as delicate electroscopes, he obtained, also accidentally, the same convulsions by bringing the copper hook on which the nerve hung, and the limb itself, simultaneously in contact with an iron railing. The similarity of the result led him to attribute it to the same cause—viz., electricity either existing in the limb itself or produced in the conducting arc of metal. On consideration, he adopted the former hypothesis, and looked upon the limb as a self-charging Leyden jar, with the nerve as the brass knob and wire, the interior of the muscle as the inner coating, its exterior the outer coating, and the metal arc as the discharging tongs. He first published his researches in 1791. Volta, 1792, discarded the account given by Galvani of his experiment; and from the fact that the convulsions in question took place with more energy when there were two metals in the conducting arc instead of one, attributed the source of electricity to the heterogeneity of the metals employed. He maintained that at the surface of contact of two different metals an electric force arising from their heterogeneity is generated, which throws them into different tensions. This doctrine forms the fundamental principle of the *contact theory* of galvanism. In reply to

Volta, Galvani proved incontestably that the contraction in the limbs of the frog took place when only one metal was employed, and even when the conductor was not of metal at all. Subsequent discovery has proved Galvani to be partly right in attributing the cause of these convulsions to animal electricity, and Volta also to be partly right in attributing them to electricity generated in the metal arc, for both causes may be at work in producing the result. Volta's theory of contact is still maintained, though another theory obtains no less support which attributes the source of galvanic electricity to the chemical action of a liquid on a metal coupled with another metal less easily acted on than itself. Fabroni, a Professor at Florence, was the first (1792) to suggest chemical action as one of the causes at work in Galvani's experiment. Volta did not accept of Galvani's vindication, but supported his theory by several apparently conclusive experiments. In 1799 he constructed, as the crowning evidence of the truth of his reasoning, his pile, and with it properly begins the history of galvanism. To Galvani is thus due the merit of discovering a new manifestation of electricity; to Volta is due the merit of displaying in it a source of power of incalculable importance, and which, but for his genius, might have remained among the barren curiosities of science. Hence it becomes a question of some difficulty to decide to which of the two the science we are discussing owes its origin—whether it is to be called Galvanism or Voltaism. Priority of discovery has led men generally to decide in favor of Galvani, although Volta has almost equal claim to have his name attached to the science. The first account of Volta's pile reached England in a letter to Sir Joseph Banks by the inventor (1800). A few weeks afterwards Carlisle and Nicholson decomposed water with it, and afterwards several salts. They were the first to use platinum electrodes. Davy, in the same year, traced the electricity of the pile to chemical action. Wollaston (1801) reiterated the same theory, and went the length of attributing even frictional electricity to chemical action. He proved likewise the identity of the two electricities, and showed that by diminishing the electrodes to mere points, the electricity of the machine could produce the same chemical effects as that of the pile. In 1802 Cruikshank improved the construction of the pile by disposing the plates horizontally in a trough instead of vertically in column. The main features of electro-chemical decomposition were discussed by Davy in his famous Bakerian lecture of 1806. In 1807 the same philosopher obtained, for the first time by galvanic agency, the metals potassium, sodium, barium, strontium, calcium, and magnesium. Deluc (1809) first made dry piles of gold and silver paper, and these were altered and improved by Zamboni (1812). In 1813 Davy discovered the electric light and voltaic arc by means of the colossal battery then placed at his disposal at the Royal Institution. Œrsted (1820) first observed the action of the current on the magnetic needle; and a few months afterwards Ampere discovered the law of this action, and originated an electric theory of magnets which has proved wonderfully fertile in practical results. In the same year Schweigger invented the galvanometer. In 1825, Becquerel, with the aid of his differential galvanometer, investigated the conductibility of metals. Kemp, in 1826, first used amalgamated zinc for the galvanic battery. In 1827 Ohm gave a mathematical theory of the pile, rigidly deduced from Volta's fundamental principle, and in perfect keeping with experiment. Faraday (1831–32) published his discoveries of the induction of electric currents, and of the evolution of electricity from magnets, which have since enriched the science with the induction-coil and the magneto-electric machine. This distinguished electrician discovered (1833–34) the definite nature of electro-chemical decomposition, and proved that electro-chemical and chemical equivalents were identical. In 1836 Daniell constructed his constant battery. Spenser in England, and Jacobi in Russia, made, simultaneously (1837), the discovery of electro-metallurgy. Grove (1839) constructed his nitric-acid battery. Faraday (1840) gave his proof of the truth of the chemical theory. Smee's battery dates also from this year. In 1843 Wheatstone, by means of his rheostat and resistance-coils, investigated the resistances offered by various conducting substances to the current. In the same year Bunsen introduced his carbon battery. The rivalry between the chemical and contact theorists has favored the advancement of the science, each party calling in the aid of experiment to support their views. Among the more distinguished contact theorists may be mentioned Volta, Ritter, Pfaff, Biot, Deluc, Ohm, and Fechner; and among the chemical theorists, Fabroni, Davy, Wollaston, Parrot, De La Rive, and Faraday. Davy latterly maintained a theory of distribution and equilibrium of electricity midway between the two, which numbered among its supporters Jæger, Berzelius, Ermann, and Prechtl. Recently (1860 onwards), Sir William Thomson has given what he considers to be convincing proofs of Volta's contact theory, but he modifies the theory so far as to render it consistent with the conservation of force.

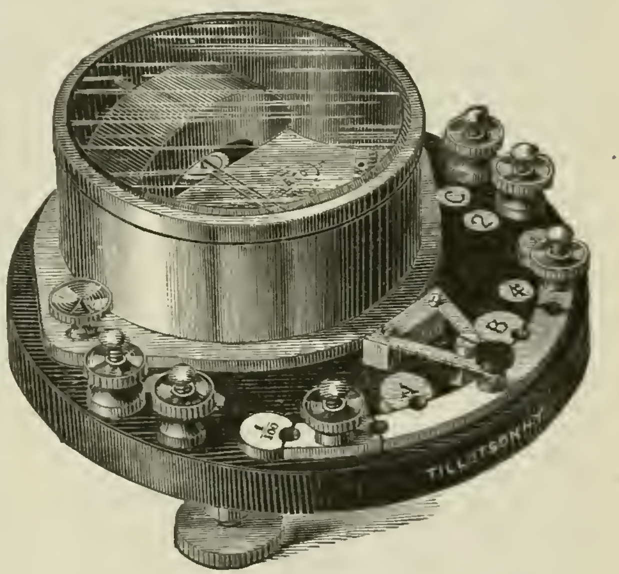


FIG. 1.

When two plates of copper and amalgamated zinc (zinc whose surface has been rubbed over with mercury) are placed in a vessel containing water to which a small quantity of sulphuric acid has been added, so long as they are kept from touching, either within or without the liquid, they remain apparently unaffected. If, however, they be made to touch, bubbles of hydrogen gas are formed in abundance at the copper plate, and their formation continues until the plates are again separated. If the contact be maintained for some time, and the plates and liquid be afterwards examined, it is found that the copper plate weighs exactly the same as before, that the zinc plate has lost in weight, and that the liquid contains the lost zinc in solution in the form of the sulphate of that metal. The contact need not be affected by the plates themselves. If wires of copper, or any other conductor of electricity, be soldered to the plates, or fixed to them by binding-screws, and be made to touch, the changes just mentioned take place as if the plates were in contact. When the wires are thus joined and, so to speak, form one connecting wire between the plates, they exhibit very peculiar properties. If a portion of the connecting wire be placed parallel to a magnetic needle, and the needle brought near, its north end no longer points to the north, but to a point either to the east or west of it, and this deviation ceases with the separation of the wires. It is not even necessary that the wires be in contact, for if their ends be put into a vessel containing a conducting liquid the same changes occur, though to a diminished extent, the contact being completed through the liquid. The ends of the wires, when so immersed, show strong chemical affinities. If the conducting liquid were a solution of the sulphate of copper, the wire from the zinc becomes coated with the copper of the solution, whilst the other attracts its oxygen and sulphuric acid, and wastes away in entering into combination with them. The connecting wires are found, therefore, in actual or virtual combination, to possess very marked magnetic and chemical properties. The arrangement just described constitutes a *galvanic pair*, which may be generally defined to be *two dissimilar conducting plates immersed in a liquid which can act chemically on one of them, and capable of being placed in conducting connection:* and the properties just referred to form the characteristic powers of galvanic electricity. These properties arise from the wires in connection being the seat of a constant discharge or flow of electricity, for they are possessed, though to a very feeble extent, by the electricity of the friction electric machine. If the prime conductor of a powerful electric machine be connected with one of the binding-screws of an insulated galvanometer, and a wire connected with the ground be fixed into the other, the plate on being turned causes a current of electricity to pass from the machine to the ground through the coil of the galvanometer, the needle of which will then show a deviation of one or two degrees. The deviation, so far as direction is concerned, is the same as that which would be produced by placing the wires coming from the copper and zinc respectively in the same binding-screws as those connected with the machine and the ground. This would indicate that the copper plate stands electrically in the same relation to the zinc plate as the prime conductor of the machine to the ground. The electricity of the conductor is positive, and that of the ground by induction negative; so that in the galvanic pair the copper plate, by analogy, gives off the positive electricity, and the zinc plate negative. Again, let the wire from the machine end in an insulated vessel containing a solution of the sulphate of copper, and let the end of a fine platinum wire connected with the ground be made to dip below the surface of the solution, and let the machine be kept in action so as to send a current of electricity through the wires and liquid: at the end of some minutes the point of the platinum wire will be covered with a minute quantity of copper. The wire connected with the zinc in the galvanic pair and that connected with the ground are thus shown to display the same chemical power; and this, again, shows us that the zinc plate, like the ground in the above experiment, is the seat of negative electricity. The electric condition of the plates before contact reveals, with the aid of a delicate electrometer, positive electricity in the copper plate, and negative in the zinc plate. If the wire joined to the zinc plate, or, as we may write it shortly, zinc wire (not, however, necessarily a zinc wire), be connected with the ground, and the insulated copper wire be made to touch the lower plate of a condenser whilst the finger touches the upper, on both being withdrawn, the leaves of the electroscope diverge with the positive electricity sent to it from the copper plate. It can be shown, moreover, that the current is not confined to the connecting wire, for if a magnetic needle be suspended between the plates when they lie north and south, slightly above the surface of the liquid, it will deviate from its usual position when the wires are joined, and in the opposite way to that which it shows when held above the wire placed in the same direction. The current thus passes within the liquid from the zinc to the copper the opposite way to that in which it runs in the connecting wires, so that it makes a complete circuit. Hence we may conclude, generally, that *in the galvanic pair a current of electricity runs within the liquid from the chemically active to the chemically passive plate, and without the liquid, from the chemically passive to the chemically active plate, making a complete circuit;* and that if the connection be interrupted the pair shows electric polarity, the *chemically passive plate being the positive pole, and the chemically active plate the negative pole.* The theory of the action of the galvanic pair may be thus given. When the two plates are put into the water and sulphuric acid they assume opposite electric states. There is developed

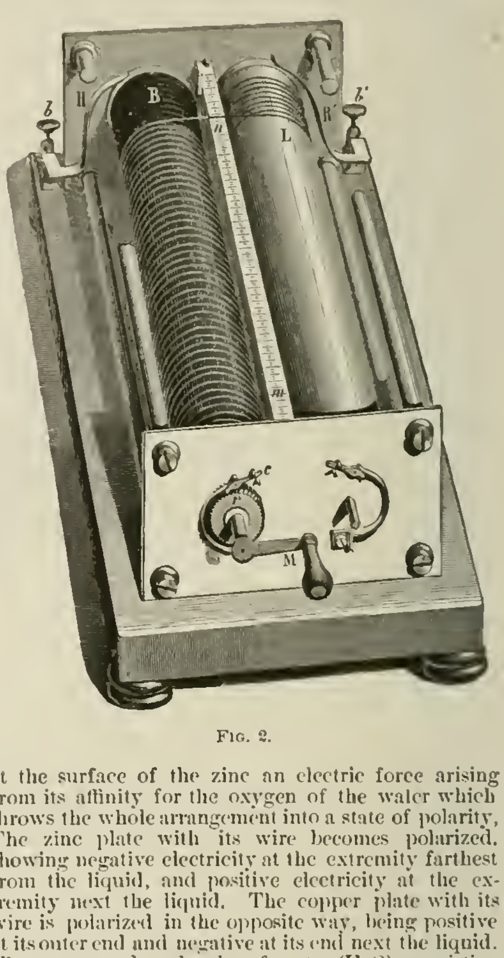


Fig. 2.

at the surface of the zinc an electric force arising from its affinity for the oxygen of the water which throws the whole arrangement into a state of polarity. The zinc plate with its wire becomes polarized, showing negative electricity at the extremity farthest from the liquid, and positive electricity at the extremity next the liquid. The copper plate with its wire is polarized in the opposite way, being positive at its outer end and negative at its end next the liquid. The compound molecules of water (H_2O), consisting of oxygen (O) and hydrogen (H_2), are likewise polarized, but the polarization takes place in the individual molecules. It appears, moreover, to have reference to their compound nature, and we may imagine them placed in series, with their oxygen or negative pole toward the zinc, and their hydrogen or positive pole towards the copper. When the ends of the wires are brought near each other, we might anticipate that a spark discharge would restore quiescence. This, however, is not the case, for the electric tension is so low that nothing short of contact can effect a discharge. When the discharge thus takes place, the polarity of the circuit for the instant ceases; the tendency to union of the zinc with the atom of oxygen next it is completed by the formation of the oxide of zinc. But in order to accomplish this, the hydrogen of the molecule of water next the zinc thus set free unites with the oxygen of the neighboring molecule to re-form the water, and the same transference and union is continued along the whole series until the hydrogen of the molecule next the copper is thrown on the copper, where, being unable to unite chemically with it, it is given off as a gas. From the fact that pure water has almost no action on zinc, a more probable hypothesis is held that it is not the water but the sulphuric acid (H_2SO_4) that is concerned in the action. We have H_2 as before; but instead of O we have SO_4, a compound molecule forming zincic sulphate (Zn_2SO_4) at once. In either case the zinc is left clean, either by the acid dissolving the oxide or the water present dissolving the sulphate. After the first discharge, therefore, the whole is as at first, so that a second discharge instantly follows, then a third, and so on. A series of discharges is thus transmitted through the circuit, constituting what is known as a current.

In a wire where a current of galvanic or frictional electricity is passing there is no point which forms the seat of positive or negative electricity, but it appears electrically homogeneous throughout. It exerts no statical inductive action on surrounding objects, neither attracting nor repelling them, for the electric action being more easily propagated along the wire than in any other direction, takes place only in it. The laws of induction and distribution applicable to frictional statical electricity hold true in a current electricity only at the section of the wire or conductor along which the action is transmitted. As tested by the magnetic needle, there is no part of the circuit which possesses more power than another. This homogeneity gives rise to the hypothesis that every molecule of the circuit, whether solid or liquid, acts in the transmission of the electric force, and is similarly affected in its passage. In this way the plates and connecting wires show the same molecular polarity as the liquid, only the discharge does not effect an interchange among the molecules, but leaves them in the same condition as before. Each molecule of the connecting wire may be viewed to be the seat of electric polarity and discharge with its negative faces turned towards the copper, and its positive towards the zinc; whenever, therefore, we go with the current we meet each molecule on its negative side, and whenever we go contrary to the current we meet each molecule on its positive side. Any portion of the circuit shows its negative face to the approaching current, and its positive face at the other extremity. A break in the connecting wire thus separates two contiguous molecules; that ending the copper wire shows itself positive, and that ending the zinc wire negative. This is in perfect keeping with experiment, for wherever a break or change of medium is made in the circuit without stopping the current—as in the electric light, chemical decompositions, the visible passage of electricity in vacuous tubes, and the like—the ends or poles exhibit opposite powers, from the pole meeting the current discharging negative, and the other positive, electricity. The polarity displayed at such interruptions, or visible passages of the current, is necessarily different from the polarity of frictional electricity, for the dynamical manifestation of electric force cannot be the same as the statical; in the same way that motion, for instance, the dynamical manifestation of the force of gravity, is essentially different from weight, or its statical manifestation. Within the galvanic pair itself the same polarity is shown: the zinc plate, without the liquid or the wire connected with it, is found to act as a negative pole, and the similar copper plate and wire as a positive pole; but within the liquid of the cell the zinc plate shows the same chemical affinities as the exterior positive pole, and the similar copper plate acts as the exterior negative pole. The terms positive and negative poles are merely relative, for every molecule or series of molecules would thus appear to have its opposite poles. They serve, however, conveniently to express the relations of two consecutive parts of the circuit. Considerable confusion sometimes arises from speaking of the zinc plate as at once the positive element and negative pole, and the copper the negative element and positive pole of the galvanic pair, and such expressions seem even inconsistent. The truth is that the zinc and copper plates must have each both poles from the very nature of the circuit; but as the outer poles only of these plates are of practical importance, these are considered to be the poles. According to the one-fluid theory of electricity, a force is developed at the seat of the action which has the power of liberating the electric fluid, and of maintaining it in motion throughout the circuit, constituting a current in the true sense of the term. According to the two-fluid theory, two such currents, one of the positive and the other of the negative fluid, are made to move in opposite directions throughout the circuit. The propelling force is consequently termed *electromotive*, and the galvanic pair is called the *electromotor*. The terms current and electro-motive have their origin in the supposed fluidity of electricity, but being quite definite in their application, they may be used without any such admission. A current may be taken to signify, apart from all supposition, simply the peculiar electric condition of the conductor, which forms the line of discharge between a positive and a negative source of electricity, and electro-motive force may be used simply to denote that which propagates and maintains this discharge. In the same way, when we speak of the direction of the current, we only use a convenient way of showing at which end the positive and negative electricities arise, the current being always represented as moving from the positive to the negative. The greater the electro-motive force is, the more powerfully is the discharge effected, and the more is it able to force its way through imperfect conductors. It would seem probable that the source of the electro-motive force in the galvanic pair is the chemical action which takes place at the zinc plate. It must have appeared, even to the most cursory observer, highly probable that the seat of the most active change going forward in the pair is likewise the origin of the force accompanying it. It is found, moreover, when we tax the galvanic current with electro-chemical work, that the amount of work done by it is exactly proportionate to the quantity of zinc dissolved. These and similar considerations seem to argue strongly that galvanic action has its source in chemical action. Volta, however, and several of the most eminent authorities in the science, maintain that the electro-motive force has its seat at the surface of contact of heterogeneous metals, and that chemical action is not the cause but the manifestation of it. This view of the origin of galvanic electricity is called the *contact theory*, as distinguished from the *chemical theory*, the one we have hitherto followed. The contact theory supposes that at the surfaces of contact of two heterogeneous substances an electro-motive force, invariable in direction and amount, is generated and subject to modification only by the resistance offered by the conducting circuit. The galvanic pair is accounted for by this theory in the following way: Let us suppose, for the sake of explanation, that both zinc and copper plates are connected by copper wires. The seat of electromotive force is at the junction of the copper wire with the zinc. At this point the two metals assume opposite electricities—the copper the negative, and the zinc the positive; and since a conducting circuit through wires, plates, and liquid is established, these electricities travel in opposite directions, and, meeting, neutralize each other within the liquid, to give place to succeeding similar discharges of electricity. The discharge within the liquid takes place electrolytically. The theory is, in this case, sufficient and consistent, but it must be kept in mind that in a circuit so perfectly homogeneous the source of force may be placed anywhere without altering its conditions. It is, however, so far wrong in assuming that the contact of the metals, where there is no force lost or transformed, maintains a never-failing development of energy in the circuit—that, in fact, force can be created from nothing. Sir William Thomson and the modern advocates of the contact theory modify Volta's theory in this way. They admit with Volta that the contact of the metals charges them with different electricities, but that the chemical energy of the liquid in contact with the metals is necessary to discharge them and maintain the current. In the action of the pair three elements are to be considered—the *electro-motive force*, the *resistance*, and the *strength of the current*. The electro-motive force is proportional to the force tending to chemical action, if we adopt the chemical theory, or, on the contact theory, to difference of potential produced by the contact of the two metals. It is measured directly by the charge, or, as it is called, the potential (tension) which a cell gives to a delicate electrometer. In Thomson's reflecting quadrant electrometer, for instance, a single Daniell's cell deflects the needle so much that the spot of light moves some 2½ inches from the zero-point of the scale. The relative electro-motive powers of the various forms of cells can be ascertained by the amount of deflection indicated by such an instrument. The resistance in the circuit which is offered by the liquid of the cell and the interpolar wire or other connection, is that which tends to reduce the current or flow of electricity produced by the electro-motive force. As stated in Ohm's law, the current strength is equal to the electro-motive force divided by the resistance. The electro-motive forces of the different cells can also be compared by observing the effect, on the current strength, of a given resistance interposed in the relative circuits, whose own proper resistance has been previously known. The unit of electro-motive force now adopted by British electricians is called a *volt*. This is about 7 per cent less than that of a Daniell's cell. The unit of resistance is called an *ohm* or B. A. unit. 485 meters of pure copper wire 1 millimeter in diameter offer an ohm of resistance; so does about $\frac{1}{13}$ of a mile of ordinary telegraph-wire (No. 8). The unit of current strength is called a *farad*, and is the amount of flow of electricity that would be produced in a second if the cell of a volt in power were to act in a circuit of one ohm of resistance. One million volts are called a megavolt; one millionth of a volt, a microvolt. The same proportion holds for a megohm and a microhm, a megafarad and a microfarad. In the centimeter, gram, second series of electro-magnetic units, an ohm is expressed as 10^9, a farad as 10^{-1}, and a volt as 10^8.

When a number of copper and zinc pairs, similar to the one already referred to, are put together, so that the copper plate of one cell is placed in conducting connection with the zinc plate of the next, they constitute a galvanic battery. The term battery is sometimes also applied to a number of cells acting as one combination, in whatever way they may be connected. When the terminal copper and zinc plates are connected, the current runs from each copper to each zinc plate without the liquids, and from each zinc to each copper plate within the liquids; and when the contact is broken, the zinc pole shows negative, and the copper pole positive, electricity. The galvanic battery acts thus in all respects as a compound galvanic pair. If the polar wires be connected with a tangent galvanometer, the deflection of the needle caused by the battery will be exactly the same as that effected by one of the cells, provided the wire be thick and a good conductor; but if the zinc end be connected with the ground, and the electric tension of the insulated copper pole be tested by a condenser and torsion-balance, its tension is found to be as many times greater than the tension of the same pole of one cell examined in the same way as there are cells in the combination. Thus, if two cells be taken, the tension is doubled; if three, tripled; and so on. *The electro-motive force of a battery is therefore proportional to the number of cells*, supposing, of course, that they are arranged consecutively. Hence the electricity of a battery is better able to force its way through imperfect conductors than that of the simple pair. When the interpolar communication is formed by a thick short wire, a single cell produces as powerful an effect on the magnetic needle as a battery; but if it be formed by a bad conductor, such as a long and thin wire, or a liquid, the effect is very different. The current of the pair is then nearly stopped, and its influence on the needle small, while that of the battery continues to flow comparatively unimpaired. When a battery is put up in series, it is said to have a tension arrangement; when put up so that several of the cells are grouped together, so as to act as one large cell, it is said to have a tension arrangement. Thus 20 cells are arranged for tension when joined in succession; but they may be disposed so as to act as one large cell 20 times as large, or as

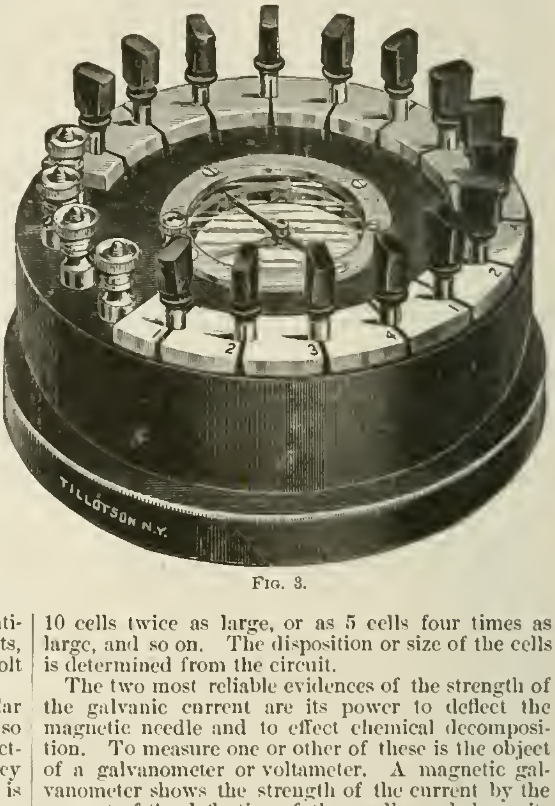


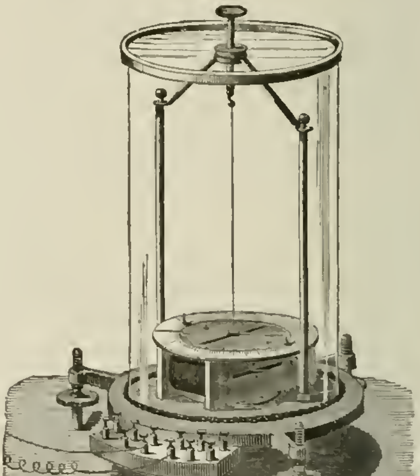
FIG. 3.

10 cells twice as large, or as 5 cells four times as large, and so on. The disposition or size of the cells is determined from the circuit.

The two most reliable evidences of the strength of the galvanic current are its power to deflect the magnetic needle and to effect chemical decomposition. To measure one or other of these is the object of a galvanometer or voltameter. A magnetic galvanometer shows the strength of the current by the amount of the deflection of the needle, and shows its direction by the way in which it deflects, as explained in the article GALVANOMETER. The *tangent galvanometer* consists essentially of a thick strip of copper, bent into the form of a circle, from one to two feet in diameter, with a small magnetic needle, moving on a graduated circle, at its center. When the needle is small compared with the ring, it may be assumed that the needle in any direction it lies holds the same relative position to the disturbing power of the ring. This being the case, it is easy to prove that *the strengths of currents circulating in the ring are proportionate to the tangents of the angles of deviation of the needle.* Thus, if the deflection caused by one galvanic couple was 45°, and of another 60°, the relative strengths of the currents sent by each would be as the tangent of 45 to the tangent of 60°—viz., as 1 to 1.73. The needle can never be deflected 90°, for since the tangent of 90° is infinitely large, the strength of the deviating current must be infinitely great, a strength manifestly unattainable. The tangent galvanometer can consequently be used to measure the strongest currents. The *differential galvanometer*, adapted to the requirements of battery-tests and all fine, accurate measuremen of resistances, is shown in Fig. 1 It is used with the rheostat to measure any resistance from one one-hundredth of an ohm upward. The *voltameter* was invented by Faraday for testing the strength of a current. In this apparatus two platinum plates, each about half a square inch in size, are placed in a bottle containing water acidulated with sulphuric acid; the plates are soldered to wires which pass up through the cork of the bottle; binding-screws are attached to the upper ends of these wires; a glass tube fixed into the cork serves to discharge the gas formed within. When the binding-screws are connected with the poles of a battery, the water in the bottle begins to be decomposed, and hydrogen and oxygen rise to the surface. If, now, the outer end of the discharging-tube be placed in a trough of mercury (mercury does not dissolve the gases), and a graduated tube, likewise filled with mercury, be placed over it, the combined gases rise into the tube, and *the quantity of gas given off in a given time measures the strength of the current.* The voltameter chooses as a test the work which the current can actually perform, and establishes a uniform standard of comparison. The indications of the tangent galvanometer are comparable only with its own, but the quantity of gas discharged by the voltameter, corrected for pressure and temperature, is something quite absolute. However, by comparing the indications of both instruments with each other when placed in the same circuit, an absolute standard may likewise be got for the tangent galvanometer. If, for instance, the current given by a battery should give 60 cubic centimeters of gas in a minute, and produced at the same time a deflection of 45° in the galvanometer, the ratio of 60 to the tangent of 45°—viz., 60 to 1 = 60—is constant, for correct measurements of the strength of currents, however taken, must bear to each other a constant ratio. If the angle of deviation for another current was 30°, we have therefore only to multiply 60 by the tangent of 30°, to ascertain the amount of gas that would be liberated by a current of that strength in a minute. This found, we know the meaning of a deflection of 30° of the galvanometer in question in a perfectly comparable standard. The plates of the voltameter must be small, for when they are large a small quantity of electricity is found to pass without decomposing the water. It is found also that a minute quantity of the oxygen forms hydric peroxide with the water, and remains in solution, so that when very great accuracy is required the hydrogen alone ought to be measured.

It is found that the dimensions and material of substances included in the circuit exercise an important influence on the strength of the current. It is of the greatest importance to ascertain the relative amount of the resistance offered by conductors of various forms and materials. The *rheostat*, invented by Wheatstone, is generally employed for this purpose, and for this object is constructed so as to introduce or withdraw a considerable amount of highly resisting wire from the circuit without stopping the current. It is represented in Fig. 2. Two cylinders, B, L, about 6 inches in length and 1½ inches in diameter, are placed parallel to each other, both being movable round their axis. One of them is of brass, the other is of well-dried wood. The wooden cylinder has a spiral groove cut into it, making forty turns to the inch, in which is placed a fine metallic wire. One end of the wire is fixed to a brass ring, and its other end is attached to the nearer end of the brass cylinder. The brass ring just mentioned is connected with the binding-screw b' by a strong metal spring. The further end of the cylinder, B, has a similar connection with the binding-screw b. The key, M, fits the projecting staple of either cylinder, and can consequently turn both. As the brass cylinder, L, is turned in the same direction as the hands of a watch, it uncoils the wire from the wooden cylinder, B, making it thereby revolve in the same way. When the wooden cylinder is turned contrary to the hands of a watch, the reverse takes place. The number of revolutions is shown by a scale, *mn*, placed between the two, and the fraction of a revolution is shown by a pointer moving on a graduated circle. When the binding-screws b and b are included within a circuit, say b' with the positive, and b with the negative pole, the curreut passes along the wire, on the wooden cylinder, till it comes to the point where the wire crosses to the brass cylinder; it then passes up the cylinder B to the spring and binding-screw b. The resistance it encounters within the rheostat is met only in wire, for as soon as it reaches the large cylinder the resistance it encounters up to b may be considered as nothing. When the rheostat is to be used, the whole of the wire is wound on the wooden cylinder, the binding-screws are put into the circuit of a constant cell or battery along with a galvanometer, astatic or tangent. If, now, the resistances of two wires are to be tested, the galvanometer is read before the first is put in the circuit. After it is introduced, in consequence of the increased resistance offered by it, the needle falls back, and then as much of the rheostat wire is unwound as will bring the needle back to its former place. The quantity of wire thus uncoiled in the rheostat is shown by the scales, and is manifestly equal in resisting power to the introduced wire. The first is then removed, the rheostat readjusted, and the second wire included, and the same unwinding goes on as before. To fix our ideas, let the quantity of wire unwound in the first case be 40 inches, and in the second case 60 inches; 40 inches of the rheostat wire offer as much resistance to the current as the first wire, and 60 inches of it as much as the second. We have thus 40 to 60 as the ratio of the resistances of the two wires. The wire of the rheostat, from its limited length, can only be comparable with small resistances; and where great resistances are to be measured, supplementary *resistance-coils* of wires, of a known number of ohms, are introduced into the circuit, or removed from it, as occasion requires, leaving to the rheostat to give, as it were, only the fractional readings. This being premised, it will be easily understood how the following results have been ascertained. It is proved, for instance, that the *resistances of wires of the same material, and of uniform thickness, are in the direct ratio of their lengths, and in the inverse ratio of the squares of their diameters.* Thus a wire of a certain length offers twice the resistance of its half, thrice of its third, and so forth. Again, wires of the same metal, whose diameters stand in the ratio of 1, 2, 3, etc., offer resistances which stand to each other as 1, ¼, ⅑, etc.; therefore the longer the wire the greater the resistance; the thicker the wire the less the resistance. The same holds true of liquids, but not with the same exactness. For this reason, the larger the plates of a galvanic pair, and the nearer they are placed to each other, the less will be the resistance offered to the current by the intervening liquid. The following table of the resistances, expressed in ohms, offered by a wire one meter long and one millimeter in diameter at 0° Centigrade, has been determined by Dr. Mathiessen: silver annealed, 0.01937; copper annealed, 0.02057; gold annealed, 0.02650; aluminium annealed, 0.03751; zinc, 0.07244; platinum annealed, 0.1166; iron annealed, 0.1251; tin, 0.1701; lead, 0.2526; mercury, 1.2247; and German silver, 0.2695. With copper at 32° F. as 1, the following liquids stand thus: saturated solution of the sulphate of copper, at 48° F., 16,885,520; ditto of chloride of sodium at 56° F., 2,903,538; sulphate of zinc, 15,861,-267; sulphuric acid, diluted to $\frac{1}{12}$, at 68° F., 1,032,-020; nitric acid, at 55° F., 976,000; distilled water, at 59° F., 6,754,208,000. The slightest admixture of a foreign metal alters the resistance very decidedly: ½ per cent of iron in copper wire increases the resistance more than 25 per cent. It has been found also that the resistance offered by a wire increases as its temperature rises. It is almost needless to add that the conducting powers of metals are inversely as their specific resistances, the least resisting being the best conducting. A combined galvanometer and rheostat, made specially for field-service, is represented in Fig. 3. It is much used for measuring the resistance of all instruments, batteries, and lines not exceeding two thousand ohms. It is graduated from one tenth of an ohm upward, is accurately adjusted for exact, quick tests, and is found invaluable in testing circuits, apparatus, etc., and in locating faults. The apparatus is very portable, weighing, complete, only five pounds. See *Daniell Battery, Electricity, Electric Light, Electrolysis, Firing-battery, Galvanometer, Induction of Electric Currents, Magneto-electricity*, and *Ohm's Law*.

GALVANOMETER. — Two of the most reliable evidences of the strength of the galvanic current are its power to deflect the magnetic needle, and to effect chemical decomposition. To measure one or other of these is the object of a galvanometer or voltameter. A magnetic galvanometer shows the strength of the current by the amount of the deflection of the needle, and shows its direction by the way in which it deflects. The manner in which a needle should turn when influenced by a current is easily kept in mind by Ampere's rule: *Suppose the diminutive figure of a man to be placed in the circuit, so that the current shall enter by his feet, and leave by his head; when he looks with his face to the needle, its north pole always turns to his left.* The deflecting wire is supposed always to lie in the magnetic meridian. The *astatic galvanometer*, or *galvanometer*, is used either simply as a galvanoscope, to discover the existence of a current, or as a measurer of the strengths of weak currents. When a needle is placed under a straight wire, through which a current passes, it deflects to a certain extent, and when the wire is bent, so as also to pass below the needle, it deflects still more. This is easily understood from the above rule. The supposed figure has to look down to the needle when in the upper wire, and to look up to it in the lower wire, so that his left hand is turned in different ways in the two positions. The current in the upper and the lower wire moves in opposite directions, thus changing in the same way as the figure; and the deflection caused by both wires is in the same direction. By thus doubling the wire, we double the deflecting force. If the wire, instead of making only one such circuit round the needle, were to make two, the force would be again doubled; and if several, the force (leaving out of account the weakening of the current caused by the additional wire) would be increased in proportion. If the circuits of the wire be so multiplied as to form a coil, this force would be enormously increased. Two needles, as nearly the same as possible, placed parallel to each other, with their poles in opposite ways and suspended, so as to move freely, by a thread without twist, have little tendency to place themselves in the magnetic meridian, for the one would move in a contrary direction to the other. If they were exactly of the same power, they would remain indifferently in any position. They cannot, however, be so accurately paired as this, so that they always take up a fixed position, arising from the one being somewhat stronger than the other. This position is sometimes in the magnetic meridian, sometimes not, according as the needles are less or more perfectly matched. Such a compounded needle is called *astatic*, as it stands apart from the directing magnetic influence of the earth. If an astatic needle be placed in a coil, so that the lower needle be within the coil, and the upper one above it, its deflections will be more considerable than a simple needle, for two reasons: in the first place, the power which keeps the needle in its fixed position is small, and the needle is consequently more easily influenced; in the second place, the force of the coil is exerted in the same direction on two needles instead of one, for the upper needle being much nearer the upper part of the coil than the lower is deflected alone by it, and the deflection is in the same direction as that of the lower needle. An astatic needle so placed in a coil constitutes an astatic galvanometer. Round an ivory bobbin, in one of these instruments, a coil of fine copper wire, carefully insulated with silk, is wound, its ends being connected with binding-screws. The astatic needle is placed in the bobbin, which is provided with a vertical slit to admit the lower needle, and a lateral slit to allow of its oscillations, and is suspended by a cocoon thread to a hook supported by a brass frame. The upper needle moves on a graduated circle; the compound needle hangs freely, without touching the bobbin. The whole is included in a glass case, and rests on a stand supported by three leveling-screws. When used, the bobbin is turned round by a screw until the needle stands at the zero-point, and the wires through which the current is sent are fixed to the binding-screws. The number of degrees that the needle deflects may then be read off. Very sensitive galvanometers, now taking the places of all others in military mining, are those designed by Messrs. Queen and Company, United States. The engraving



Queen Convertible Galvanometer.

shows the instrument provided with leveling-screws and astatic needles, suspended from a brass arm by a fiber of unspun silk, with an arrangement for adjusting the zero of the scale to the axis of the coils. It is convertible by a moment's adjustment from an ordinary *quantity* galvanometer into one for *intensity*, or into a differential galvanometer for either *intensity* or *quantity*.

With these most essential instruments, the cables are from time to time examined to ascertain if their insulation is effective, and if they have a sufficient amount of electricity; if the firing-battery is in a condition to insure certain ignition; if the electrical connections of the circuit-closers are correct; if the electrical resistance of the fuse is such as to indicate certainty of ignition, and other similar information. A separate galvanometer should be used for each mine, and a special battery, distinct from the firing-battery, employed in connection with the testing-circuits; thus obviating the necessity of detaching the firing-battery while testing,—an important matter likely to occur at the critical period when vessels are attempting to break through the lines. Should any leak be discovered in a cable, the extent of it is shown by the galvanometer; and if considerable, the defective cable is detached from the battery and the fault repaired. When a mine is fired, it is important that its cable should be disconnected at once from the firing-battery, to prevent loss of power through the broken end of the conductor. When a separate galvanometer is supplied for each cable of a system of mines, it furnishes a constant indicator to point out the fact of a circuit-closer being struck by a ship, and in many cases it may be convenient, or even necessary, to perform the operation of throwing in the firing-battery without the aid of a personal operator. A self-acting apparatus has been devised for doing it. By making the apparatus purely self-acting, all chances of error consequent upon the inattention or want of dexterity of the man in charge is, of course, eliminated. No mine or circuit-closer can be tampered with by an enemy without the fact being instantly known in the testing-room, and precisely what mine. See *Galvanism*.

GAMA-GRASS.—A genus of grasses distinguished by unisexual flowers placed in spikes which are fertile at the base and barren towards the extremity, the spikelets having two glumes and about two florets, the female florets immersed in the thick and sinuous joints of the rachis, so that the spike, when the seed has ripened, presents the appearance of a cylindrical bone. Only two species are known of which the gama-grass of Mexico, distinguished by having spikes usually three together, has a high reputation as fodder-grass, is excellent for the stock in the field, and is cultivated not only in Mexico, but also in the United States of America, and to some extent in Europe. In favorable circumstances this grass yields a very abundant crop, and attains a height of nine or ten feet, its root-leaves measuring six feet in length. It possesses what for some climates is an almost invaluable property of bearing excessive drought without injury. It suffers, however, from frost. It seems eminently adapted to the climate of the Australian Colonies. The other species, the gama-grass of Carolina, distinguished by solitary spikes, is not so much esteemed.—Gama-grass is said to have derived its name from a Spanish gentleman who first attempted its cultivation in Mexico.

GAMBADO.—A case of leather formerly used to defend the leg from mud, and when riding on horseback.

GAMBESON—GAMBOISON.—A coat of mail worn under the cuirass. It consisted of a doublet of leather or linen cloth without sleeves, and quilted so that it was entirely covered with stitches. The high *gambeson* with cuishes and leggings, which in the fourteenth century was worn under the earliest suits of plate-armor, was also in leather or linen lightly quilted. Somtimes written *Gambesan*.

GAMELLE.—A wooden or earthen bowl formerly used among the French soldiers for their messes. It generally contained the quantity of food which was allotted for three, five, or seven men belonging to the same room. During the Monarchy of France subaltern officers and volunteers were frequently punished for slight offenses by being sent to the *gamelle* and excluded from their regular mess. On such occasions they were put upon short allowance, according to the nature of their transgressions.

GANG-DRILLS.—A number of drills so attached together, or to a common stock, as to act together. In a form of vertical gang-drill, much used in the manufacture of small-arms, the spindles are of steel, having anti-friction curved bearing at lower end, with take-up in boxes for wear, also answering the purpose of a step, doing away with the trouble caused by expansion in the length of spindle. The spindles are driven by a belt longer than is usually found on this class of drills, which overcomes the objection commonly raised against them. These drills, for armory purposes, are constructed in sizes as follows:

No.	No. of Spindle.	Size of Table.	Greatest Distance between Table and End of Spindle.	Length of Belt on Spindle.	Distance between Spindle-centers.	Center of Spindle to Column.	Diam. of Spindle.	Weight, lbs.
1	4	26 × 32 in. or smaller.	22 in.	5 ft. 9 in.	7⅜ in.	11 in.	1¼ in.	1,750
1	6	26 × 22 in. or smaller.	"	" "	4½ "	11 "	1¼ "	1,950
2	3	12½ × 22½ in.	20 in.	5 ft.	6 "	7½ "	1⅛ "	1,350
2	4	" " "	"	"	4 "	7½ "	1⅛ "	1,350
3	3	10 × 20 "	"	3 ft. 6 in.	5 "	7 "	1 "	720
3	4	" " "	"	" "	3½ "	7 "	1 "	720

No. 1 has 4-change cone-pulley for 3-inch belt. No. 2 has 3-change cone-pulley for 2¼-inch belt. No. 3 has 4-change cone-pulley for 2-inch belt. Pulleys on countershaft, Nos. 1 and 2, 12 inches diameter; No. 3, 10 inches diameter. Speed—No. 1, 250 revolutions; No. 2, 300 revolutions; No. 3, 350 revolutions, per minute. See *Drilling-machine*, *Drill-press*, and *Multiple Drill*.

GANGUE.—The stony matrix in which metallic ores occur. Quartz is the most common gangue, but calc-spar is also very frequent, sulphate of barytes and fluor-spar not unfrequent. Large portions of the gangue are generally worked and submitted to metallurgic processes for the sake of their contents. The term is also applied to the superfluous earthy matter of a smelting-furnace.

GANTLET—GAUNTLET.—A glove of iron which formed part of the armor of knights and men-at-arms. The back of the hand was covered with plates jointed together, so as to permit the hand to close. Gantlets were introduced about the thirteenth century. They were frequently thrown down by way of challenge, like gloves. They are frequently used in Heraldry, the fact of their being for the right or left hand being expressed by the words "dexter" or "sinister." In the phrase "To run the gantlet," the word is probably a corruption for *ganglope* (from *gang*, a passage, and the root occurring in e-*lope*—D. *loopen*, Ger. *laufen*, to run). The German has *gassenlaufen* (lane-run), meaning the military punishment, which consists in making the culprit, naked to the waist, pass repeatedly through a lane formed of two rows of soldiers, each of whom gives him a stroke, as he passes with a short stick or some other similar weapon. The term is frequently applied to a long glove covering the wrist and used generally as a riding-glove. See *Gloves*.

GANTLOPE—GANTLET.—A military punishment which consisted in making the culprit, naked to the waist, pass repeatedly through a lane formed by two rows of soldiers, each of whom gave him a blow with an iron glove or gantlet as he passed. Subsequently whips and canes were used instead of gantlets, until such a mode of punishment became obsolete. See *Gantlet*.

GAOL.—A withe used for binding fascines or securing gabions. Also a prison. See *Gabion*.

GARCON MAJOR.—An officer so called in the old French service. He was selected from among the Lieutenants of a regiment to assist the Aid Majors in the general details of duty.

GARDANT.—A term in Heraldry, said of an animal which is represented full-faced and looking forward. See *Passant-gardant*.

GARDE-FAUDE.—Over the flanks, on each side of the figure, to the *faudes* or *taces* was appended a plate or small shield, called a *garde-faude* (usually called *tuille* in England). These plates appeared in almost every variety of forms—square, hexagonal, lozenge-shaped, serrated, etc. In front and behind, the haubergeon was shown uncovered.

GARDE-GENERAL D'ARTILLERIE.—An officer, under the old Government of France, who had charge of all the ordnance and stores belonging to his Majesty for the land-service. He gave receipts for all ammunition, etc., and his bills were paid by the Treasurer General of the Army.

GARDE NATIONALE.—The Garde Nationale, the celebrated burgher defenders of order in Paris and certain other French towns, was for the first time introduced into Paris during the Revolution of 1789. It had existed for a long time previous in some of the French towns, having been at first employed to defend the rights and privileges of the city, and subsequently to guard the persons and property of the citizens. When, in July, 1789, the entire lower orders of the Capital rose and demanded arms, the leaders of the Revolution, sitting at the Hôtel de Ville, seized the opportunity to decree, without consulting the Government, the formation of a National Guard for Paris of 48,000 citizens, which, in the first instance, they named the Parisian Militia. Each electoral district was to enroll a battalion of 800 men, divided into 4 companies of 200 men each, 15 of these companies forming a legion. The officers of the battalions were to be elected by the privates; but the higher officers were named by the Committee. The device chosen as the badge of the service was of blue and red, the colors of the city, to which white, the color of the army, was added, to denote the intimate union which should subsist between the defenders of national liberty and the military. Thus arose the celebrated tricolor, afterwards adopted as the national badge, and now borne in honor wherever the French name extends. On the King consenting to the removal of the regular troops from Paris, Lafayette was named Commandant of the National Guard of the City. Ere many more days had elapsed, the friends of municipal freedom had organized themselves into burgher troops in every important town, and the National Guard had become a recognized institution of the whole kingdom, the entire number raised being not under 300,000. The force soon acquired an extraordinary degree of discipline and efficiency—in a great degree from the number of old soldiers who, having deserted the crown, were elected to commissions by the municipal troops. By an ordinance of June, 1851, the Garde Nationale was placed nearly on the footing of Louis Philippe's reign; but by a decree of 1852, which held till September 4, 1870, the entire force was dissolved, and reformed on a more military basis, in certain Departments only. During the Franco-Prussian War the Garde Nationale was divided into sedentary and active battalions. After the defeat of the Commune, in 1871, the French National Assembly decreed to dissolve the Garde Nationale, leaving the Prefects of Departments to choose the time of executing the decree. At present this body may be considered abolished, as its existence is incompatible with the new law of recruiting.

GARDE PLUIE.—A machine originally invented by a Frenchman, and submitted to the Prussians, who adopted it for the use of their infantry. Under the cover of these machines, the besieged or the troops stationed in the posts attacked would be able to keep up a brisk and effective discharge of musketry during the heaviest fall of rain, and thereby silence to some extent the fire of the enemy.

GARDE-REINS.—A part of the plate-armor of the Middle Ages, intended to protect the lower part of the back. See *Armor*.

GARDES-BRAS.—A piece of armor for the protection of the arms. See *Arm-guards*.

GARDES DE LA PORTE.—A company so called during the Monarchy of France, and of so ancient a date, indeed, with respect to original institution, that it appears to have been coeval with it. Mention is made of the *Gardes de la Porte* in the oldest archives or records pertaining to the King's Household, in which service they were employed, without being responsible to any particular Treasurer as other companies were. This company consisted of one Captain, four Lieutenants, and fifty Guards. The Captain and officers received their commissions from the King. The first took an oath of fidelity to the King in person, and accepted the bâton from his hands. His duties were purely discretionary. The Lieutenants served by detachment, and took their tours of duty every quarter. Their specific service consisted in guarding the principal gate belonging to the King's apartments. They were relieved at night by the body-guards, and delivered the keys to a Brigadier belonging to the Scotch garrison.

GARDES DU CORPS.—Under the old French Government, a certain number of gentlemen or cavaliers whose immediate duty was to attend the King's person. They were divided into four companies, under as many Captains, whose tour of duty came every quarter. They took rank above the Gens d'armes and the King's light cavalry. The first and most ancient of the four companies was called the Scotch Company, which was established by Charles VII. of France in 1423.

GARDES FRANCAISES.—A regiment formed by Charles IX., King of France, in 1563, for the immediate protection of the Palace. The Colonel of the Gardes Française was on duty throughout the year, and was entitled to the *bâton de commande* in common with the four Captains of the body-guards. Peculiar privileges were attached to every officer belonging to this body. No stranger, not even a native of Strasburg, Savoy, Alsace, or of Piedmont, could hold a commission in the French Guards. In the Revolution of 1789 they took a very active and leading part.

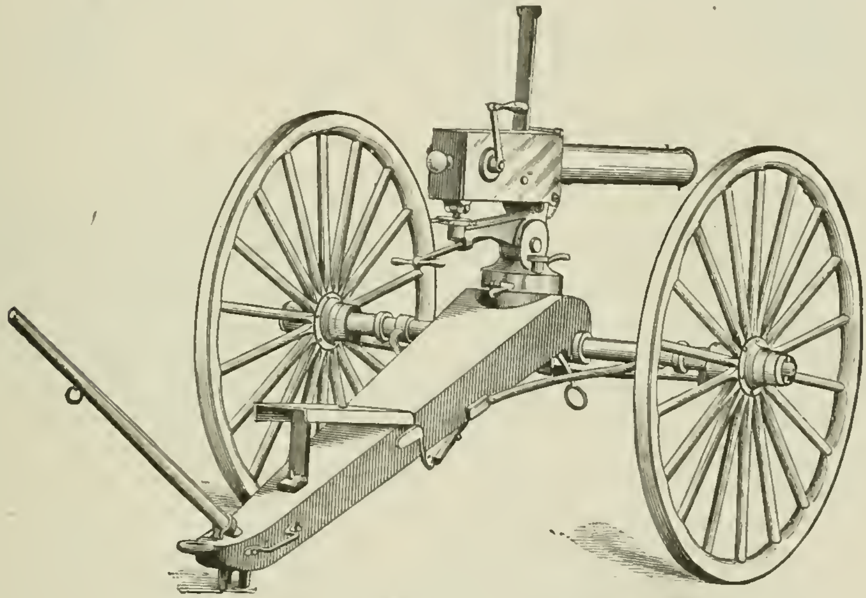
GARDES-MAGAZINS.—In the old French service there were two sorts of magazine-guards, one for the military stores and the other for the artillery. The first was subject to the Grand Master, and the second was appointed by the Secretary at War. *Gardes particuliers des magazins d'artillerie* were officers appointed by the Grand Master of Ordnance for the specific purpose of attending to the ammunition, etc. Their pay was in proportion to the quantity of stores with which they were intrusted.

GARDES SUISSES.—A celebrated corps in the French army, constituted "Gardes" by royal decree in 1616. They comprised upwards of 2000 men, were always unswerving in their fidelity to the Bourbon kings, and are quite remarkable for their heroic end. On August 10, 1792, they withstood the Parisian revolutionary mob, and defended the Palace of the Louvre till almost every man was cut down. During the resistance they offered, the Royal Family was enabled to escape to such shelter as the National Assembly afforded.

GARDE-VISURE.—The heraldic term used for what is commonly called the visor or front part of the helmet, used for the defense of the face and eyes.

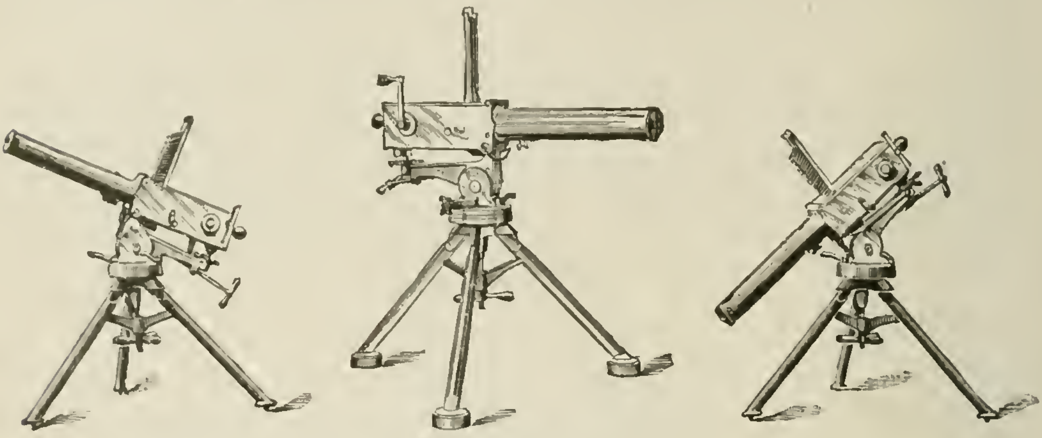
GARDNER MACHINE-GUN.—The improved Gardner gun, as shown on carriage and tripods, consists of two simple breech-loading rifle-barrels, placed parallel to each other, about 1.4 inch apart, in a *case* or *compartment*. These two barrels are loaded, fired, and relieved of shells by one revolution of the hand-crank. The working of the gun is simple. One man inserts the heads of cartridges projecting from a feed-block into the feed-guide, drawing the block from the cartridges; another man turns the crank by which the gun is fired, and as the cartridges disappear down the feed-guide, their places are supplied from another block: in this manner the firing may be made continuous. The barrels are open from end to end, and chambered at the rear to admit a flanged center-fire metallic cartridge. The barrels are firmly screwed into a *rear barrel-ring*, which is pinned fast to the rear case, and the muzzles pass through another similar ring called *front barrel-ring*, which is fitted into the front case and made fast with a taper pin. The rear case extends from rear barrel-ring far enough to contain all lock parts, together with the *driving-crank* and *safety-stop*. A swinging cover, hinged at forward end of case, is firmly locked in position by a cascabel having a screw-thread cut on its stem that enters the rear case. When the cover is raised, which can be quickly done after turning back the cascabel, all the working parts of the gun are fully exposed; and should an accident occur, like the bursting of cartridge-heads, or derangement of locks, the trouble can be instantly discovered, and as quickly remedied. The hand-crank that operates the gun is pinned fast to the *main crank*, which is supported by journal-boxes. The boxes are locked into the rear case, and serve as a protection to the swinging cover from side thrusts. The body of *main crank* is circular, having journals, or crank-pins, for operating the locks, diametrically opposite each other (the firing being alternate), and eccentric enough to give the required motion to the locks as they are moved forward and back, driving in cartridges and withdrawing shells. The outer portions of crank-pins or journals are flattened to the circle of the periphery of main crank for the purpose of holding the lock stationary while firing, about one-fifth part of revolution of hand-crank, and allowing ample time for *hang fires*. The lock in form resembles the letter U, having an extension from its side which contains the *firing-pin*, the main (spiral) spring, sector or spring compressor, sector-sleeve, extractor, and lock-head. The U part of the lock, that works under and around the crank-pin, is curved at the inner front to correspond with the outer circle of the crank; the office of the curved front being to hold the lock in position for firing. The circular firing-pin is flattened a portion of its length near the front end, to allow it to pass under the extractor by which it is held in position. It extends from the head of the lock through the mainspring and sector-sleeve, terminating in a flange or head for locking into a sear. The sear, having the form of a bell-crank, pivoted in the center to the lock, holds the firing-pin securely, and prevents it from touching the cartridge until it is released from its hold by the action of the crank-journal when the lock is in its extreme forward position. The sector, or spring compressor, hinged in a recess of the lock, and engaging, by means of gear teeth, with the sector-sleeve, has its arm forced against the safety-stop as the main crank advances, thus compressing, through the medium of the sector-sleeve, the mainspring, and holding it tense until released by action of the sear.

The lock-heads serve as breech-plugs, and receive the recoil when the cartridges are fired. Each lock carries a *hook extractor*, which rides over and catches the flange of the cartridge when the lock is forced forward, and when the lock retreats withdraws the empty shell until it comes within reach of the ejector, by which it is positively thrown out. The shell-starters have a positive movement in connection with the lock-head. Should the cartridge be driven by the extractor into the barrel, to its head (as is the case when the gun is worked rapidly), before the lock is in firing position, it is forced from the chamber by the shell-starter as the lock advances, and is held long enough for the extractor to engage with the head, when the lock, extractor, and cartridge are driven home together. The ejectors, hinged to the case, are driven by projections on the sides of the locks which give them positive movements to eject the empty shells. They also serve as stops to prevent cartridges from falling through the perforated plate as they are forced down through the feed-valve. The lock-guide extending across the rear case, to which it is fastened by a pin, has two parallel semicircular grooves, which are enlarged *extensions* of the chambers in barrels. From the back part of the groove, slots large enough to pass freely the cartridges (being wider at the rear, behind the ejector, than at the front) are cut downward through the plate. When the retractor has drawn the shell back nearly to the extent of the throw of the crank, the ejector forces the shell through the slot, and is then in position to receive another cartridge from the feed plate or valve. The feed-valve, attached to the swinging cover, has a reciprocating motion across the perforated plate. It has two angular openings of the size and shape of the outline of the cartridge, with centers equidistant with centers of barrels. After a cartridge has dropped one half its diameter into the valve, it is forced by the action of the latter into its true position, and held positively against the *cartridge-support*. When the valve is again moved back, the cartridge is forced downward into the perforated plate, and the column of cartridges is cut off in the swinging cover feed ways, which are extensions of the *feed-guide* that is located above and in line with the lock-guide. The feed valve is driven by the *feed-plate* lever; this also is attached to the swinging cover and is operated by the locks, using about one eighth the stroke of the crank in its forward motion, thereby giving the valve ample time to hold both cartridge and shell down in position as they move in and out from the barrel. The *feed-guide*



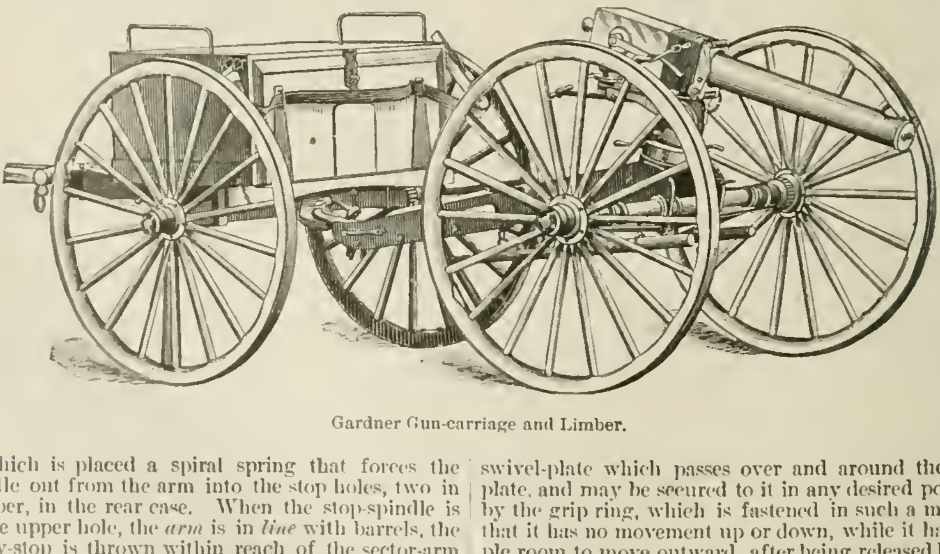
Gardner Machine-gun mounted on Carriage.

is a simple plate having two parallel T-grooves, extending from end to end, their centers equidistant with the centers of the barrels. The upper end of the guide has a trumpet shaped mouth to facilitate the entrance of the cartridge-heads. The lower end is provided with a cartridge stop, which lifts all cartridges contained in the guide when it is taken out from the swinging cover by which it is supported. The guide is held fast in firing position by a spring catch. It can be quickly released by drawing back



Gardner Machine-gun mounted on Tripod.

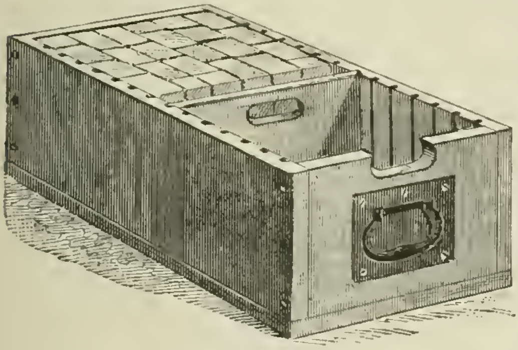
the spring catch by pressure on its exposed arm. In placing the guide in position, the spring catch becomes self-acting. These operations require but one hand, leaving the other free to place the safety-stop arm in position. The safety-stop is an oblong block having an angular face against which the arm of the sector in the lock may engage when the locks are moved forward by the crank. It is held in position by two links which are moved by an arm that is pinned fast to a shaft passing through the rear case, to the outer end of which is pinned the stop-arm. This arm is constructed in the form of a hand crank, having a stop-spindle placed in its handle, behind the shoulder



Gardner Gun-carriage and Limber.

of which is placed a spiral spring that forces the spindle out from the arm into the stop holes, two in number, in the rear case. When the stop-spindle is in the upper hole, the *arm* is in *line* with barrels, the safety-stop is thrown within reach of the sector-arm by which the mainsprings are compressed, and the gun is in firing position. When the spindle is in the lower hole the stop is carried forward out of the way of the sector-arm, and in no case can the springs be compressed while the safety-stop arm is down.

The carriage of the gun is of new design and construction, and is made entirely of steel and bronze. The frame for the carriage, including the side walls, bed-plate, and axle-support, is made in one casting. The lunette body and ring, the handspike ring and socket, and ground-recoil stop-support are also in one casting. The top and side trail-plates are supported at their upper corners by angle-irons, to which they are riveted. These angle-irons extend from the frame to the body and are riveted to them. Lost motion is prevented in the wheels on the arms of the axles by conical sleeves sliding into the boxes of the wheels (their ends being cupped to receive the same) against conical washers supported by linch-pins. The sleeves are forced outward by a toggle-joint actuated by a hand-lever (underneath the trail), and can be locked either in or out. Ample compensation is made for wear of surfaces by right- and left-hand screws locked by jam-nuts. The circular bed-plate of the carriage, that supports the swivel-plate of the mount, is provided with a taper socket to receive the spindle of the swivel-plate, which has a circular groove into which is inserted, by means of a lever, a sliding-bolt for holding down the swivel-plate which passes over and around the bed-plate, and may be secured to it in any desired position by the grip ring, which is fastened in such a manner that it has no movement up or down, while it has ample room to move outward, after being released by the grip-ring screw-handle, and the mount then has full range of the horizon. The base of the mount slips over and around the swivel-plate, and is held from uprising by the nut and the lock-pin on a round bolt that passes through the spindle of the swivel-plate. On the upper face of the swivel-plate is a segmental T groove to receive the head of a clamp-bolt that projects upward through the front of the base-plate. A handle-nut clamps the parts fast when the oscillator is not in use. The amplitude of oscillation is twenty degrees, and can be decreased at will by turning the oscillator stop-screw on the upper face of the base. From the base-plate project upwards two walls, forming the outer portion of a joint in which rest the walls of the mount-body. On the inner side of the body are two circular beveled friction-plates, the outer surfaces of which are forced against the inner sides of the mount; these in turn are forced against the walls of the base, and that is supported by a bolt passing through the whole and secured by a washer and nut. The friction-plates are held from rotary motion by a stout pin that passes through the whole. On the friction-plates is a grip-ring, the screw of which passes underneath the rear body of the mount far enough to form a pointing-lever with its cross-handle, thus instantly performing two functions, as the hands do not leave the screw until the gun is pointed and secured, in any position from thirty degrees elevation to forty degrees depression. At the front of the mount-body extending upward is the arm for supporting the gun-casing, which is bored for attachment by an ordinary pin-hinge. The mount-body extends far enough back to receive the nut for the elevating-screw, in the upper part of



Ammunition-drawer.

which is a sliding box to receive the pin that makes connection with the rear of the casing. The caisson that accompanies the gun is of the usual United States pattern. The chest is of oak and carries eight ammunition packing-drawers, having also sufficient space for appendages and tools. The accompanying drawing represents one of the eight drawers to be carried in the limber-chest. Each drawer holds forty-five pasteboard paper-covered cartridge packing-cases, which may be made water-proof. Each case holds twenty cartridges. The total amount of ammunition carried in the caisson is 7200 rounds. The cases are packed on end, and are supported by each other in such a manner that they cannot be shaken around or upturned, and all liability of jamming bullets or shells is prevented. The drawers have on their inside walls a series of grooves equal in number to one third of the paper cases to be packed. A movable partition (that can be withdrawn by one motion of the hand) is arranged to fit the grooves. After the drawer has received its full amount of cases, the movable partition is inserted into the grooves at the end of the drawer, thereby forming an inner wall, supporting and locking the cases firmly in position. In order to break bulk, the partition is removed, thus leaving space enough to admit the fingers to break out the first case, after which there can be no difficulty. When a portion of the cases have been removed from the drawer, it is *absolutely* necessary to secure those remaining, and the movable partition can be inserted into the grooves nearest the cases, thus securing them, even to the *last case*, as firmly as though the bulk had not been broken. The partition is secured to the drawer by a stout cord, so that there is no danger whatever of its becoming lost. See *Machine-gun*.

GARDNER MAGAZINE-GUN.—In this arm the barrel and tip-stock slide forward and backward on ways connected with the butt-stock. They are released to move forward, and secured when back by a hook into which the forward end of the trigger-guard is formed. This guard revolves, to a sufficient extent for this purpose, on a pin passing through it, at the forward end of the guard-bow. It locks the piece automatically, when it is closed, by the action of a spring at its rearmost end. In moving out the barrel the hammer is cocked by an internal connection between the barrel and the tumbler. A cartridge having been expelled backward from the magazine by the action of the magazine-spring, it is raised by the striking of a projection on the lower end of the barrel against the forward end of a bent lever, the rearmost end of which lies beneath the cartridge. This passes it up a pair of guides on the face of the frame, so shaped as to hold within their jaws the head of the cartridge by the rim. When it arrives opposite to the mouth of the chamber it is passed into it by closing the piece. By repeating the movements as described, the succeeding cartridge will pass up the guides as before, and striking from below the empty one just fired, will throw it up the guides with sufficient force to send it clear of the gun. The magazine is charged through the trough into which the space between the ways is formed. The issue of the cartridges from the magazine is limited to one at each forward motion of the barrel by the interposition of a spring stop, which is pressed out of the way by the barrel at the end of its stroke. The magazine can be cut off and held in reserve by a revolving eccentric stop, moved by a thumb-piece on the outside. The arm can then be used as a single-loader by inserting the rim of the cartridges into the guides at each opening of the piece. By a cam-motion of the movable trigger-guard power is obtained to start the barrel slightly away from the butt, and thus to overcome the chief obstacle to the removal of the empty shell, viz., its sticking at the start.

GARLAND.—A variety of chaplet made of flowers, feathers, and sometimes of precious stones, worn on the head in the manner of a crown. Both in ancient and modern times it has been customary to present garlands of flowers to warriors who have distinguished themselves. A beautiful young woman was generally selected for that purpose.

GARNISHED.—A term in Heraldry. Any charge is said to be *garnished* with the ornaments set on it.

GARNISH-NAILS.—Diamond-headed nails, in early times used to ornament artillery-carriages.

GARRET.—A term formerly and commonly used to signify a turret or battlement. It is now obsolete.

GARRISON.—A body of troops stationed in or near a fort or fortified town to defend it, or to keep the inhabitants in subjection. The garrison of a work, when it is practicable, should always be a complete organization, or composed of detachments belonging to the same unit of force. Garrisons should not live within field-works unless there is a pressing necessity for this to be done. As a rule, they should encamp near the works they are to defend, and only keep guards within the works. Nevertheless the engineer or other officer who lays out a field-work should always consider the possibility of its being occupied by a garrison, and should provide the necessary accommodations, so far as interior space may be required. The proportion of men given for the protection of a garrison generally has for its object both the number required for the immediate security of the place and that required to sustain a siege; an arrangement which in peace avoids the necessity of shutting up a considerable body of troops without an immediate object. See *Post*.

GARRISON COURT-MARTIAL.—A legal tribunal for the examination and punishment of all offenders against martial law, or against good order and military discipline.

The following is a form of record for a Garrison Court-Martial:

GARRISON COURTS-MARTIAL.
First Day.

Proceedings of a Garrison Court-Martial held at Fort ——, ——, pursuant to the following order:

HEADQUARTERS FORT ——, ——,
——, 187 .

Post Orders }
No. —. }

A Garrison Court-Martial will convene at this Post on the —— ——, 187 , at 10 o'clock A.M., or as soon thereafter as practicable, for the trial of such prisoners as may properly be brought before it.

Detail for the Court.

First Lieutenant A. B., —— Artillery.
First Lieutenant C. D., —— Artillery.
Second Lieutenant E. F., —— Artillery.
Second Lieutenant G. H., —— Infantry, J. A.

By command of —— ——:

(Signed) —— ——,
1st *Lieutenant* —— *Artillery*,
Post Adjutant.

FORT ——, ——,
——, 187 .

The Court met, pursuant to the foregoing order, at —— o'clock A.M.

Present:

First Lieutenant —— ——, —— Artillery.
First Lieutenant —— ——, —— Artillery.
Second Lieutenant —— ——, —— Artillery.
Second Lieutenant —— ——, —— Infantry, J. A.

The Court then proceeded to the trial of Private —— ——, Battery ——, —— Regiment U. S. Artillery, who was then brought before the Court, and having thereupon heard the order convening it read, was asked if he had any objection to being tried by any member named therein, to which he replied in the negative. The Court, including the Recorder, was then duly sworn according to law in the presence of the prisoner.

The mode of swearing a Regimental or a Garrison Court is as follows:

The junior member of the Court is its Recorder, and administers to the other two members the oath prescribed in the article for members, after which the Presiding Officer administers to the Recorder the following oath, which combines with the oath of a member the additional obligation required of the Judge Advocate, or person officiating as such:

"You, A—— B——, do swear that you will well and truly try and determine, according to evidence, the matter now before you, between the United States of America and the prisoner to be tried, and that you will duly administer justice, according to the provisions of 'An Act establishing rules and articles for the government of the armies of the United States,' without partiality, favor, or affection; and if any doubt should arise, not explained by said articles, according to your conscience, the best of your understanding, and the custom of war in like cases; and you do further swear that you will not divulge the sentence of the Court to any but the proper authority, until it shall be duly disclosed by the same; neither will you disclose or discover the vote or opinion of any particular member of the Court-Martial, unless required to give evidence thereof, as a witness, by a Court of Justice, in a due course of law. So help you God."

The record from here on is made up in the same general manner as indicated for the proceedings of General Courts-Martial. The junior member, as Recorder or Clerk to the Court-Martial, should, with the President, authenticate its proceedings in each and every case.

In the absence of a Judge Advocate, or person officiating as such, as a prosecuting attorney for the United States, with *legal* obligations to the prisoner—confined, however, simply to objecting to any leading or criminating question—the Court itself proceeds with the business referred to it, summons all necessary witnesses, and asks all questions tending to elucidate the matter, pro and con, without denial to the prisoner of his right to ask any additional question pertinent to the issue, or to make any statement *respectful* in its character.

Equal obligation rests on each member of the Court to well and truly try and determine, according to evidence, the matter before it, and to duly administer justice.

Questions by the Recorder, or any other member, if not objected to, become "*Questions by the Court.*"

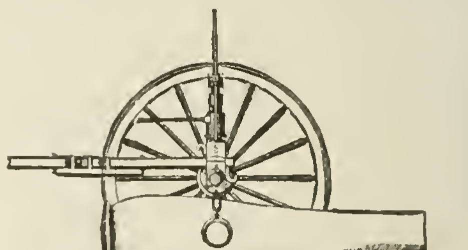
The "decision and orders" of the Reviewing Officer, confirming, disapproving, or remitting the sentence, should follow immediately after the signature of the President and Recorder, and be signed *by him*, and not by his command, and then forwarded, without delay, together with a copy of his Post or Regimental Order promulgating the proceedings, to Department Headquarters, for the supervision of the Department Commander. See *Courts-Martial.*

GARRISON DES JANISSARIES.—The *élite* or flower of the Janissaries of Constantinople was frequently sent into garrison on the frontiers of Turkey, or to the places where the loyalty of the inhabitants was doubted. The Janissaries did not indeed assist in the immediate defense of a besieged town or fortress, but they watched the motions of all suspected persons, and were subject to the orders of their officers, who usually commanded the garrison.

GARRISON-FLAG.—In the United States service, the garrison-flag is the national flag. It is made of bunting, thirty-six feet fly and twenty feet hoist, in thirteen horizontal stripes of equal breadth, alternately red and white, beginning with the red. In the upper quarter, next the staff, is the Union, composed of a number of white stars, equal to the number of States, on a blue field, one third the length of the flag, extending to the lower edge of the fourth red stripe from the top. This flag is furnished only to very important posts, or those having large garrisons, and is hoisted only on gala-days and great occasions. See *Flags.*

GARRISON-GIN.—The largest size of gin. It is strongly built and used for raising heavy ordnance, driving piles, etc., and consists of three poles, each from 12 to 15 feet long, and 5 inches in diameter at the lower end, tapering to 3½ inches at the upper. The poles are united at the top, either by an iron ring which passes through them or by a rope which is twisted several times around each, and to this "joint" a pulley is fixed. Two of these poles are kept at an invariable distance by means of an iron rod, in order that they may support the windlass which is attached to them, its pivots running in iron cheeks fixed to the poles. When the machine is to be used, it is set up over the weight to be raised; two blocks arranged according to the Second System of Pulleys are fixed, the one to the top of the poles, the other to the weight; and the rope, after passing around both blocks, and over the pulley before mentioned, is attached to the windlass, by the revolution of which the weight can then be raised. See *Gin.*

GARRISON SLING-CART.—A form of sling-cart for moving very heavy weights. It is attached by its pole to a siege- or field-limber, and may be drawn by horses. With this cart the weight is raised by first

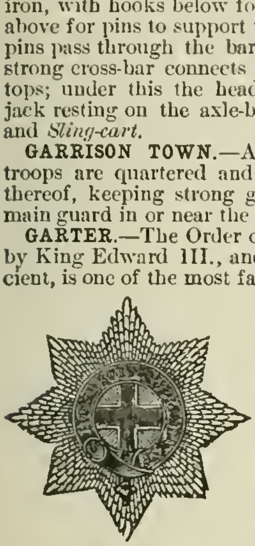


attaching to it a sling, and then applying to the sling the hooks forming the lower part of a powerful screw passing up through the axle of the cart. Above the axle is the nut of the screw, provided with long handles. Power is applied to these handles, and the screw is run up, thus raising the weight.

This sling-cart is capable of carrying 20,000 pounds; but with such heavy weights the handles of the screw are difficult to turn. To overcome this difficulty a modification has been made in the cart by substituting for the screw a hydraulic jack. Through the axle-body two vertical mortises are cut, each at a distance of twenty inches from the middle of the axle-body. Through these mortises slide two stout bars of iron, with hooks below for the sling-chain, and holes above for pins to support them as they are raised; the pins pass through the bars above the axle-body. A strong cross-bar connects the upright bars near their tops; under this the head of the jack is applied, the jack resting on the axle-body. See *Hand Sling-cart* and *Sling-cart.*

GARRISON TOWN.—A strong locality in which troops are quartered and do duty for the security thereof, keeping strong guards at each post, and a main guard in or near the market-place.

GARTER.—The Order of the Garter was instituted by King Edward III., and though not the most ancient, is one of the most famous of the military orders of Europe. Selden says that it "exceeds in majesty, honor, and fame all chivalrous orders in the world." It is said to have been devised for the purpose of attracting to the king's party such soldiers of fortune as might be likely to aid in asserting the claim which he was then making to the crown of France, and intended as an imitation of King Arthur's round table. The round table was erected at Windsor, and the knights and nobles who were invited from all parts of the world were exercised at tilts and tournaments as a preparation for the magnificent feasts that were spread before them. That general "jousts and tournaments" of this description were held at Windsor is assured from the letters summoning them bearing date January 1, 1344, and quoted by Sir Harris Nicolas in his *Orders of Knighthood,* and also from the narrative of Froissart, who connects them with the institution of the order. The original number of the Knights of the Garter was twenty-five, his Majesty himself making the twenty-sixth. The story that the Countess of Salisbury let fall her garter when dancing with the King, and that the King picked it up and tied it round his own leg, but that, observing the jealous glances of the Queen, he restored it to its fair owner with the exclamation, *Honi soit qui mal y pense,* is about as well authenticated as most tales of the kind, and has, moreover, in its favor that it accounts for the otherwise unaccountable emblem and motto of the order. Sir Harris Nicolas, whose error does not usually lie in the direction of credulity, says that though the writers on the order have treated it with contempt, they have neither succeeded in showing its absurdity nor suggested any more probable theory. Various dates are assigned to the Order of the Garter. Froissart, as above mentioned, gives 1344, and fixes on St. George's Day (April 23), 1344; but Stow, and, it is said, the statutes of the order, fix it six years later, viz., 1350. The original statutes have long since perished, and little reliance can be placed on the modern copies of them, and nothing is known on the subject with precision till the compilation of the *Black Book* in the latter part of the reign of Henry VIII. In these circumstances Sir Harris Nicolas is of opinion that, though founded at the former period, it was not till the latter that the order was finally organized and the Companions chosen. It was founded in honor of the Holy Trinity, the Virgin Mary, St. Edward the Confessor, and St. George; but the last, who had become the tutelary saint of England, was considered its special patron; and for this reason it has always born the title of "The Order of St. George," as well as of "The Garter." A list of the original Knights, or Knights-founders, is given by Sir Harris Nicolas. The well known emblem of the order is a dark blue ribbon edged with gold, bearin the motto *Honi soit qui mal y pense,* in gold letters, with a buckle and pendant of gold richly chased. It is worn on the left leg below the knee. The mantle is of blue velvet lined with white taffeta, and on the left breast a star is embroidered. The hood and surcoat are of crimson velvet lined with white taffeta. The hat is of black velvet, with a plume of white ostrich-feathers, in the center of which there is a tuft of black herons' feathers, all fastened to the hat by a band of diamonds. The collar is of gold, and consists of twenty-six pieces, each in the form of a garter. The "George" is the figure of St. George on horseback encountering the Dragon, and is worn hanging from the collar; there is a "lesser George" pendent to a broad dark blue ribbon over the left shoulder. The star, which is of eight points, is silver, and has upon the center the cross of St. George, gules, encircled with the garter. The officers of the order are—the Prelate (the Bishop of Winchester), the Chancellor (the Bishop of Oxford), the Registrar, (the Dean of Windsor), the Garter King of Arms, and the Usher of the Black Rod.



Star of the Order of the Garter.

GARTER KING OF ARMS.—The Garter King of Arms is also the principal King of Arms in England. Though held by the same person, they are distinct offices. The first was instituted for the service of the Order of the Garter, not on its first foundation, but afterwards by Henry V. as Sovereign, with the advice and consent of the Knights-companions. The peculiar duty of Garter King of Arms is to attend upon the Knights at their solemnities, to intimate their election to those who are chosen by the order, to call them to be installed at Windsor, to cause their arms to be hung up over their stalls, and to marshal their funeral processions, and those of royal personages, and of members of the higher nobility. In the capacity of Principal King of Arms, he grants and confirms arms, under the authority of the Earl Marshal, to whom he is not subject as Garter King of Arms. All new grants or patents of arms in England are first signed and sealed by Garter King of Arms, and then by the king of the province to which the applicant belongs. See *Garter.*

GAS.—The term gas was employed by the older chemists to designate any kind of air or vapor. Van Helmont was the first chemist who limited the term gas to such elastic fluids as had not been rendered liquid or solid by the reduction of temperature. In common language some distinction is made between gases and vapors. Gases are understood to be invariably aëriform at ordinary temperatures and atmospheric pressures, while vapors under these conditions are solid or liquid, and only assume a vaporous or apparently gaseous form at relatively high temperatures. Thus oxygen, hydrogen, nitrogen, chlorine, etc., are considered true gases; while water, sulphur, iodine, etc., when heated to certain definite points, become transformed into vapors. There is, however, no distinction between gases and vapors in a theoretic point of view. The *kinetic theory of gases,* first put forth by Daniel Bernouilli, is to the effect that they are formed of material particles, free in space, and actuated by very rapid rectilinear movements, and that the tension of elastic fluids results from the shock of their particles against the sides of the containing vessels. This theory has been recently revived and developed chiefly by Clausius and Clerk Maxwell. Their perfect elasticity is one of the most important physical peculiarities of gases. Within the limits of all ordinary experiments it is generally true that "the volume of a gaseous body is inversely as the compressing force." In consequence of their extreme elasticity, gases exhibit an entire absence of cohesion among their particles, and in this respect they differ essentially from liquids. A vessel may be filled either partially or completely with a liquid, and this liquid will have a definite level surface or limit. With gases it is otherwise; they always perfectly fill the vessel that contains them, however irregular its form. Instead of cohesion, there is a mutual repulsion among their particles, which have a continual tendency to recede further from each other, and thus exert a pressure in an outward direction upon the sides of the vessel in which the gas is inclosed. This outward pressure is greater or less according as the elasticity of the gas is increased or diminished. Dalton long ago remarked that "there can scarcely be a doubt entertained respecting the reducibility of all elastic fluids, of whatever kind, into liquids; and we ought not to despair of effecting it at low temperatures and by strong pressure exerted upon the unmixed gases." This prediction has been completely fulfilled. It occurred to Faraday, who led the van in these investigations, that the most probable mode of obtaining gases (or rather what, under ordinary circumstances, would be gases) in the liquid state, would be to generate them under strong pressure. When thus produced in strong bent glass tubes, they continued liquid at low temperatures while the pressure was maintained; but on removing the pressure (breaking the tube), they instantly passed into the gaseous state. In his Memoir published in the *Philosophical Transactions* for 1823 he announced that he had succeeded in liquefying chlorine, euchlorine, sulphuretted hydrogen, nitrous oxide, cyanogen, ammonia, and hydrochloric, sulphurous, and carbonic acids. Subsequently, under the joint action of powerful mechanical pressure and extreme cold, the number of liquefiable gases was so far extended as to include all except oxygen, hydrogen, nitrogen, nitric oxide, and coal-gas; and all the following gases were obtained in a solid form: hydriodic acid, hydrobromic acid, sulphurous acid, sulphuretted hydrogen, carbonic acid, cyanogen, ammonia, euchlorine, fluoride of silicon. The researches of Andrews established the fact that for every gas there is a certain minimum temperature at which the energy of the molecular movement is exactly balanced by the force of cohesion, *whatever be the pressure to which the vapor is subjected;* this temperature is the "critical point" of the gas. It was because the critical points of certain gases are very low that they so long resisted all efforts to condense them. No amount of pressure without the necessary cold could be effectual. At last, in the end of 1877, by the use of powerful apparatus and ingenious contrivances for producing cold, the difficulties have been overcome by MM. Cailletet and Raoul Pictet of Geneva. By combining a cold of 120° to 140° below zero, with enormous pressures of 550 and even 650 atmospheres, M. Pictet was able to liquefy oxygen. "He has also liquefied and even solidified hydrogen, which he has seen to issue from the tube in the form of a steel-blue liquid jet, which partly solidified. The solid hydrogen, in falling on the floor, produced the shrill noise of a metallic hail, thus confirming the bold and ingenious idea of Faraday, who first suggested that hydrogen is a metal." The distinction between permanent and condensable gases is thus abolished.

Graham's experiments with the simple diffusion-tube show that the diffusiveness or *diffusion volume* of a gas is in the inverse ratio of the square root of its density; consequently the squares of the times of equal diffusion of the different gases are in the ratio of their specific gravities. Thus, the density of air being taken as the standard of comparison at 1, the square root of that density is 1, and its diffusion volume is also 1; the density of hydrogen is 0.0692, the square root of that density is 0.2632, and its diffusion volume is $\frac{1}{0.2632}$, or 3.7994; or, as actual experiment shows, 3.83—that is to say, if hydrogen and common air be placed under circumstances favoring their mutual diffusion, 3.83 volumes of hydrogen will change place with 1.00 of air. The following table gives: 1. The density; 2. The square root of the density; 3. The calculated, and 4. The observed velocity of diffusion or diffusiveness of several important gases; the numbers in the last column, headed "Rate of effusion," being the results obtained by experiment upon the rapidity with which the different gases escape into a vacuum through a minute aperture about $\frac{1}{500}$ of an inch in diameter.

Gas.	Density.	Square root of density.	Calculated velocity of diffusion.	Observed velocity of diffusion. Air = 1.	Rate of effusion.
Hydrogen	0.06926	0 2632	3.7994	3.83	3.613
Light carburetted hydrogen	0.559	0.7476	1.3375	1.344	1.322
Carbonic oxide	0.9678	0.9837	1.0165	1.0149	1.0123
Nitrogen	0.9713	0.9859	1.0147	1.0143	1.0164
Olefiant gas	0.978	0.9889	1.0112	1.0191	1.0128
Binoxide of nitrogen	1.039	1.0196	0.9808	......	......
Oxygen	1.1056	1.0515	0.9510	0.9487	0.950
Sulphuretted hydrogen	1.1912	1.0914	0.9162	0.95	......
Protoxide of nitrogen	1.527	1.2357	0.8092	0.82	0.834
Carbonic acid	1.52901	1.2365	0.8087	0.812	0.821
Sulphurous acid	2.247	1.4991	0.6671	0.68	......

The process of diffusion is one which is continually performing an important part in the atmosphere around us. Accumulations of gases which are unfit for the support of animal and vegetable life are by its means silently and speedily dispersed, and this process thereby contributes largely to maintain that uniformity in the composition of the aërial ocean which is so essential to the comfort and health of the animal creation. Respiration itself, but for the process of diffusion, would fail of its appointed end, in rapidly renewing to the lungs a fresh supply of air, in place of that which has been rendered unfit for the support of life by the chemical changes which it has undergone. A reference to the last two columns of the above table shows that, within the limits of experimental errors, the rate of effusion of each gas coincides with its rate of diffusion. Graham's experiments show that the velocity of *transpiration* (the term which that chemist applied to the passage of gas through long capillary tubes) is entirely independent of the rate of diffusion, or of any other known property. It varies with the chemical nature of the gas, and is most probably "the resultant of a kind of elasticity depending upon the absolute quantity of heat, latent as well as sensible, which different gases contain under the same volume; and therefore will be found to be connected more immediately with the specific heat than with any other property of gases." Oxygen is found to have the lowest rate of transpiration. Taking its transpiration velocity at 1, that of air is 1.1074; of nitrogen, 1.141; of carbonic acid, 1.369; of sulphuretted hydrogen, 1.614; of ammonia, 1.935; of olefiant gas, 1.980; and of hydrogen, 2.288. In the passage of gases through diaphragms, the law of the diffusion of gases is more or less disturbed or modified according to the force of adhesion in the material of which the diaphragm is composed; the disturbance being the greatest in the case of soluble gases and a moist thin diaphragm, such as a bladder or a rabbit's stomach.

All gases are more or less soluble in water and other liquids. Some gases, as, for example, hydrochloric acid and ammonia, are absorbed by water very rapidly, and to a great extent, the liquid taking up 400 or 600 times its bulk of the gas; in other cases, as carbonic acid, water takes up its own volume of the gas; whilst in the case of nitrogen, oxygen, and hydrogen it does not take up more than from $\frac{1}{25}$ to $\frac{1}{50}$ of its bulk. As the elasticity of the gas is the power which is here opposed to adhesion, and which at length limits the quantity dissolved, it is found that the solubility of each gas is greater, the lower the temperature, and the greater the pressure exerted upon the surface of the liquid. Dr. Henry found that at any given temperature the *volume* of any gas which was absorbed was uniform, whatever might be the pressure; consequently that the *weight* of any given gas absorbed by a given volume of any liquid at a fixed temperature increased directly with the pressure. If the pressure be uniform, the quantity of any given gas absorbed by a given liquid is also uniform for each temperature; and the numerical expression of the solubility of each gas in such liquids is termed its *coefficient of absorption* or *of solubility*, at the particular temperature and pressure, the volume of the gas absorbed being in all cases calculated for 32° Fahr., under a pressure of 29.92 inches of mercury. Thus, one volume of water at 32°, and under a pressure of 29.92 inches of the barometer, dissolves 0.04114 of its volume of oxygen; and this fraction represents the coefficient of absorption of oxygen at that temperature and pressure. Similarly, the coefficient of absorption of common air is 0.02471. In consequence of this solubility of the air, all water contains a certain small proportion of it in solution; and if placed in a vessel under the air-pump, so as to remove the atmospheric pressure from its surface, the dissolved gases rise in minute bubbles. Small as is the quantity of oxygen thus taken up by water from the atmosphere, it is the means of maintaining the life of all aquatic animals. If the air be expelled from water by boiling, and it be covered with a layer of oil, to prevent it from again absorbing air, fish or any aquatic animals placed in such water quickly perish. Even the life of the superior animals is dependent upon the solubility of oxygen in the fluid which moistens the air-tubes of the lungs, in consequence of which this gas is absorbed into the mass of the blood, and circulation through the pulmonary vessels.

The following table, drawn up from the researches of Bunsen and Carius, shows the solubility of some of the most important gases, both in water and in alcohol.

Each of these gases, with the exception of hydrochloric acid, may be expelled from the water by long-continued boiling. Gases are not absorbed by all liquids in the same order; for example, naphtha absorbs most olefiant gas, oil of lavender most protoxide of nitrogen, olive-oil most carbonic acid, and solution of chloride of potassium the most carbonic oxide. If a mixture of two or more gases be agitated with water, or probably any other liquid, a portion of each gas will be absorbed, and the amount of each so absorbed or dissolved will be proportional to the relative volume of each gas multiplied with its coefficient of solubility at the observed temperature and pressure. As all ordinary liquids exert a greater or less solvent action on gases, a gas to be examined quantitatively should be collected over mercury.

The adhesion of gases to solids next requires a notice. Illustrations of this phenomenon perpetually occur. Thus, wood and other solid substances immersed in water or other liquids appear covered with air-bubbles. It is this adhesion of air to the surface of glass tubes which causes the difficulty of obtaining barometers and thermometers completely free from air. It is in consequence of the adhesion of air to their surfaces that many small insects are enabled to skim lightly over the surface of water which does not wet them. A simple method of illustrating this phenomenon is by gently dusting iron filings over the surface of a vessel of water; if we proceed carefully, a considerable mass of the iron may accumulate upon the surface; till at last it falls in large flakes, carrying down with it numerous bubbles of air. As the particles of iron are nearly eight times as heavy as water, it was only the adherent air that enabled them to float upon the surface. Closely allied to this adhesion is that remarkable property of condensation which porous bodies, and especially charcoal, exert over gases. Owing to this property of charcoal—especially freshly burned vegetable charcoal—various gases may be separated from their watery solution by filtration of the latter through it; for an example, sulphuretted hydrogen may be removed from water so completely that it cannot be detected either by its well-known odor or by the ordinary tests. Saussure found that 1 volume of freshly burned box-wood charcoal absorbed 90 volumes of ammonia, 85 of hydrochloric acid, 65 of sulphurous acid, 55 of sulphuretted hydrogen, 40 of protoxide of nitrogen, 35 of carbonic acid, 35 of bicarburetted hydrogen, 9.4 of carbonic oxide, 9.2 of oxygen, 7.5 of nitrogen, 5.0 of carburetted hydrogen, and 1.7 of hydrogen. These results follow an order very nearly the same as that of the solubility of the gases in water. Stenhouse has investigated the differences in the absorbent power of the different kinds of charcoal; the table on page 746 shows his most important results: .5 of a gram of each kind of charcoal being employed, and the numbers in the table indicating in cubic centimeters the quantity of absorbed gas.

Gas.	Volume of each gas dissolved in one volume of water.		Volume of each gas dissolved in one volume of alcohol.	
	At 32 degrees F.	At 59 degrees F.	At 32 degrees F.	At 59 degrees F.
Ammonia	1049.69	727.2	......	......
Hydrochloric acid	505.9	458.0	......	......
Sulphurous acid	68.861	43.564	328.62	145.55
Sulphuretted hydrogen	4.3706	3.2326	17.181	9.539
Chlorine	Solid.	2.368	.....	....
Carbonic acid	1.7967	1.002	4.3295	3.1993
Protoxide of nitrogen	1.3052	0.0778	4.1780	3.2678
Olefiant gas	0.2563	0.1615	3.5950	2.8825
Binoxide of nitrogen	......	......	0.31606	0.27478
Marsh gas	0.05449	0.03909	0.52259	0.48280
Carbonic oxide	0.03287	0.02432	0.20443	0.20443
Oxygen	0.04114	0.02989	0.28397	0.28397
Nitrogen	0.02035	0.01478	0.12634	0.12142
Air	0.02471	0.01795	......	....
Hydrogen	0.01930	0.01930	0.06925	0.06725

Gas used.	Kind of Charcoal employed.		
	Wood.	Peat.	Animal.
Ammonia	98.5	96.0	43.5
Hydrochloric acid	45.0	60.0	....
Sulphurous acid	32.5	27.5	17.5
Sulphuretted hydrogen	30 0	28.5	9.0
Carbonic acid	14 0	10.0	5.0
Oxygen	0.8	0.6	0.5

So rapid is this action of charcoal, that Stenhouse has proposed to use a respirator filled with it to protect the mouth and nostrils in an infected atmosphere; and the employment of trays of powdered wood-charcoal in dissecting-rooms, in the wards of hospitals, and in situations where putrescent animal matter is present, is found to act very beneficially in purifying the air by absorbing the offensive gases. Its use in reference to the filtration of water has been already allnded to. The determination of the exact specific gravity of the different gases is of great importance in calculating the proportions of the different ingredients of compounds into which they enter; and the whole series of numbers expressing the chemical equivalents or atomic weights of bodies depend upon the accuracy of the determination of the specific gravity of hydrogen and oxygen.

The following table gives the specific gravity and the weight of 100 cubic inches of some of the most important gases at a barometric pressure of 30 inches and at a temperature of 60°, together with the name of the observer:

Gas.	Specific Gravity. Air = 1.	Weight of 100 Cubic Inches in Grains.	Observer.
Air	1.0000	30 935	Regnault.
Oxygen	1.1056	34 203	"
Nitrogen	0.9713	30.119	"
Hydrogen	0.0692	2.143	"
Carbonic acid	1 5290	47.303	"
Chlorine	2.5000	76.250	Thomson.
Ammonia	0 5902	18 003	"
Carburetted hydrogen	0.5555	16 944	"
Olefiant gas	0 9722	29 652	"
Arseniuretted hydrogen	0 5290	16 130	Tromsdorff.
Sulphuretted hydrogen	1 1805	36.007	Thomson.
Cyanogen	1 8055	55 069	Gay-Lussac.
Hydrochloric acid	1.2847	39.183	Thomson.
Sulphurous acid	2.2222	67 777	"

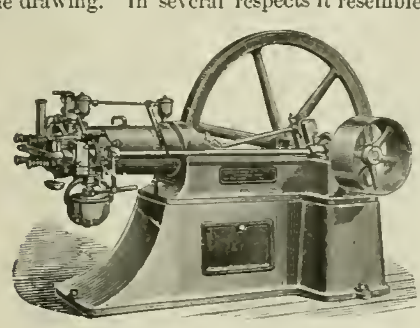
Regarding the chemical properties of gases, most of the different gases, when pure, can be readily distinguished by some well-marked physical or chemical property. Some are distinguished by their color, others by their very peculiar odor; but several of the most important ones—viz., oxygen, nitrogen, hydrogen, carbonic acid, carbonic oxide, light carburetted hydrogen, olefiant gas, and the protoxide of nitrogen—require various other means for their discrimination.

GAS CHECK.—Soon after the introduction of the Woolwich guns it became evident that a great evil had to be combated. This was that the heavy charges used, and the consequent rush of gas along the bore, especially at that portion of it immediately over the seat of the shot, seriously eroded the steel tubes of the guns. To such an extent does this erosion take place that an impression of the rear portion of the bore of a heavy Woolwich gun resembles, in its roughness, the bark of an elm-tree; and obviously this erosion shortens the lives of the guns. Gas-checks, originally introduced to prevent erosion of the bore, have been found not only to fulfill this purpose, but also to increase range and accuracy, and to be capable of giving the requisite rotation to the projectile so as to render the use of studs unnecessary. This is accomplished by bolting a flanged copper disk to the base of the shell. In the larger calibers the studs are going out of use. The projectile for the 100-ton gun receives its motion of rotation from an expanding (copper) gas-check on its base fastened by 12 screws on the base of the projectile. Under the action of the powder-gas, the check is expanded and compressed; its forward portion is compressed between the walls of the bore and the surface of the projectile, which is dentated near the base. The copper is molded to the lands and grooves exactly, giving the motion of rotation and preventing the escape of the gas. On the circumference of the gas-check are buttons which take to the grooves. These are not necessary except as a convenience in loading. They prevent the projectile from being forced down too far by the hydraulic rammer, and so crushing the powder.

In experiments with the 8-inch breech-loading rifle, both copper and steel gas-checks were used. The former proved the better gas-checks, but at times stuck to the face of the breech-block after firing, to such extent as to make it difficult to withdraw the block. With the steel gas check, however, no difficulty was found in withdrawing the block after firing, though there was at times a slight escape of gas. To remedy the defective operation of the checks constructed of a single metal (either copper or steel or other metals), a gas-check was designed and made of steel and copper combined, thus insuring in the ring the hardness and elasticity of steel at the base with the compressibility and extensibility of the copper part in contact with the walls of the gas-ring seat. This construction secures through the extensible copper a perfect and close check at the sides of the seat in the chamber of the gun, while at the same time, the check having its base of hard and unyielding steel, any binding or sticking of the breech fermeture in opening the breech is prevented. The mode of construction of an 8-inch gas-check is as follows: Two holes are punched, near either end, through a steel bar about 14 inches long, 2½ inches wide, and ½ inch thick. The bar is then slit with a chisel between these two holes, and the slit first enlarged by a mandrel, and finally formed into a circle on the anvil. It is then placed in the lathe, its bearing surface with the copper finished, and only sufficient excess of metal left elsewhere to allow subsequent slight corrections. The steel sabot is then carefully heated over a slow charcoal-fire until it attains a dull red heat, and is then immersed in a bath of rape-oil and left to cool. A 2-inch round copper bar, 14 inches long, is then similarly shaped into a ring; then placed in the lathe, its face and shoulder which bear against the steel sabot is finished, and its interior diameter roughly shaped. See *Broadwell Ring*.

GASCON—GASCONNADE.—The term *gascon* is now employed, in the French language, to denote a boaster or braggart, and *gasconnade* to signify any extravagant or absurd vaunting—the inhabitants of the district once known as Gascony having long been notorious in this respect. An example may be mentioned: A Gascon, on a visit to Paris, was asked by his city-friend what he thought of the Colonnade of the Louvre. His reply was, "Ah, it's not bad; it resembles pretty closely the back part of the stables at my father's castle!" There are in French volumes filled with the original and numerous sallies of these humorous boasters.

GAS-ENGINE.—Many attempts have been made in the arsenal to utilize as a motive power the expansive force arising from the explosion of a mixture of common coal-gas, such as is in general use for illuminating purposes, and common air. The first attempt of this kind which had any commercial success was that of Lenoir, a French inventor. It resembles in its general features an ordinary horizontal steam-engine. It has two slides, one on each side of the cylinder, which are opened and closed by eccentrics in the usual way. Through one of the slides, air and gas flow into the cylinder, in the proportions of about 11 of air to 1 of gas, until the cylinder is nearly half full, when the connection with the galvanic battery is made by the revolution of the shaft, causing a spark inside the cylinder, and consequent explosion of the mixture of air and gas. This explosion forces the piston from the middle of the cylinder to the further end. The products of the explosion then escape from the cylinder by the other slide-valve, which opens at the proper instant. The momentum which the fly-wheel has now acquired will carry the piston back to the middle of the cylinder, sucking in behind it, through openings which are made by the action of the eccentric on the slide, a fresh supply of air and gas; and when the piston has reached to the middle of the cylinder, the further inflow of air and gas is stopped by the slide closing, and at the same instant a spark of electricity is sent into the air and gas, exploding it as before. The first half of the stroke of the piston is thus employed in sucking in the requisite quantities of air and gas, and the last half of the stroke giving off the power arising from the explosion of the mixture of air and gas. Better gas-engines than Lenoir's are now in use, and one of the best is styled the Otto Silent Gas-engine, shown in the drawing. In several respects it resembles Le-



Otto Silent Gas-Engine.

noir's, but it differs from it in others. Instead of an electric spark, a small, constantly burning gas-flame is used to fire the charge. But the main difference lies in the use of a more dilute mixture of gas and air, placed under a pressure of above 30 pounds above the atmosphere, by which only a portion of the charge becomes combustible; the remainder is simply expanded, and so not only is the shock of a full explosion avoided, but there is a more sustained pressure on the piston throughout the stroke. We may compare the interior of the cylinder to that of a soda-water bottle with straight sides lengthwise, only it has no constricted portion or neck. One third of its length at the bottom end is taken up by the combustion-chamber; another third by the piston; and the remaining third, or rather more, by the space over which the piston travels. A jacket of cold water surrounds the cylinder to keep it cool. There are two openings in the combustion-chamber—one for the admission of the charge, and the other for the escape of the products of combustion. Attached to the combustion-chamber there is a slide-valve whose movements are so arranged that it first admits the air and gas in due proportions, which the return of the piston compresses, and then another movement of the valve fires the mixture by exposing it to the gas-flame. The explosion, so to call it, occurs once in two revolutions when the engine is fully loaded, but less often when it is not. In the Otto it acts on the piston at the beginning, not as in the Lenoir at the middle of the stroke; but the piston is connected in a very similar way with the fly-wheel in both engines. The cost for the gas is about one penny per hour per horse-power.

GAS-ESCAPE.—Rifled muzzle-loading built-up and converted guns are provided with small channels called *gas-escapes*, through which smoke issues on firing, if the inner tube is cracked through, thus giving warning that it is time to cease firing.

GASKET.—In artillery, a flat plaited cord used for "stoppering the fall." It may also be made (on the same principle as the *selvagee*) by placing the same number of rope-yarns in a straight line and marling down.

GAS-RING.—A thin plate of steel or copper, perforated to the exact size of the caliber of the gun, and used as a face-plate to the breech-block in Sharp's breech-loading rifle and Broadwell's breech-loading ordnance. It is used by the Prussian Government. The breech-block is chambered out larger than the hole in the plate, so that the gas from the explosion of a charge in the gun flies back into the chamber and presses the plate or ring well forward against the breech of the gun.

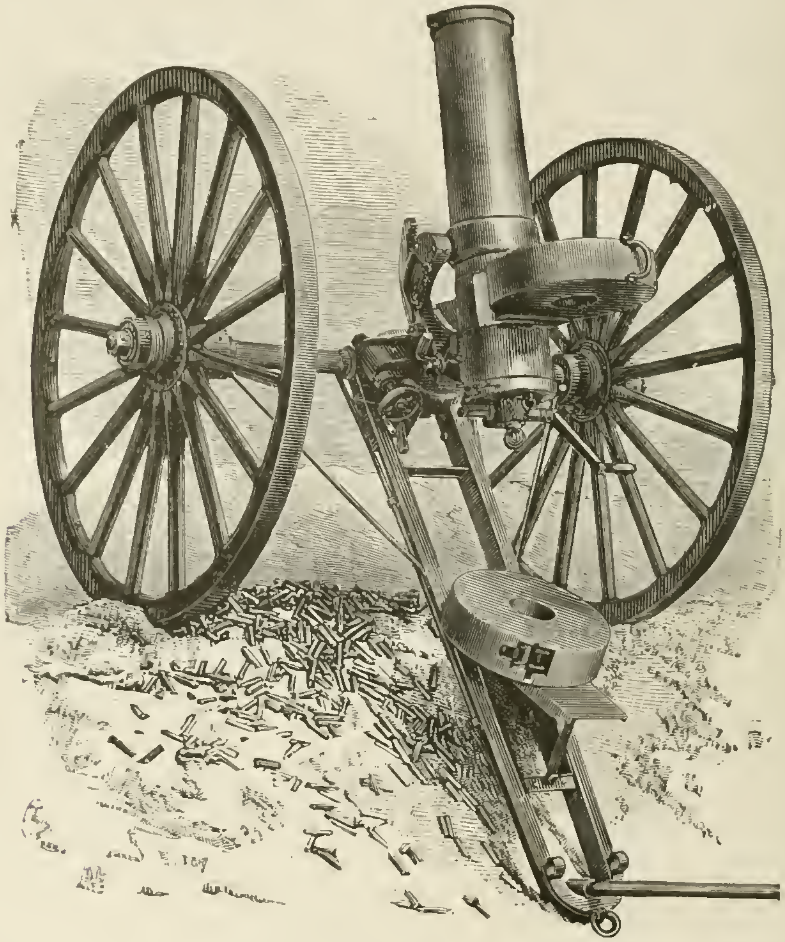
GASTRAFETES.—A very ancient variety of cross-bow, so called because the crossbow-man used to rest it on his stomach.

GATE.—A door of strong planks with iron bars to oppose an enemy. Gates are generally fixed in the middle of the curtain, from whence they are seen and defended from the two flanks of the bastions. The gate, being a most important point in all fortified places, is usually protected by various devices. It is flanked by towers with loopholes, from which assailants may be attacked, and is frequently overhung by a machicolated battlement, from which missiles of every description were poured upon the besiegers. City gates, and gates of large castles, have in all ages been the subjects of great care in construction; and when from some cause, such as the cessation of constant fighting, or a change in the mode of warfare, gateways have lost their importance in a military point of view, they have maintained their position as important architectural works, and where no longer useful have become ornamental. In very ancient times we read of the "gate" as the most prominent part of a city, where proclamations were made, and where the kings administered justice. The Greek and Roman gates were frequently of great magnificence. The propylæa at Athens is a beautiful example, and the triumphal arches of the Romans are the ornamental offspring of their city gates. Most of the towns in England have lost their walls and city gates; but a few, such as York and Chester, still retain them, and give an idea of the buildings which formerly existed, but which now remain only in the name of the streets where they once stood. English castles retain more of their ancient gates, and from these we may imagine the frowning aspect every town presented during the Middle Ages. Abbeys, colleges, and every class of buildings were shut in and defended by similar barriers; many of these still exist in Oxford and Cambridge, and the abbey gates of Canterbury and Bury St. Edmunds are well-known specimens of monastic gateways.

GATEWAY.—In works with large garrisons, where the means of frequent communication with the exterior are requisite, posterns of ordinary dimensions are found not to afford a sufficient convenience for the daily wants. In such cases a passage-way of sufficient width to admit of at least a single carriage-road with narrow foot paths on each side has to be opened through the rampart, which, whenever it is practicable to do so, should be arched and covered with earth to render it bomb-proof. The passage-way should for security have the bottom of its outlet at least twelve feet above the bottom of the enceinte ditch; and when this difference of level cannot be obtained the main ditch should be deepened sufficiently for the purpose below the outlet. A gateway of sufficient height and width for the passage of the ordinary vehicles for the service of the garrison is made through the scarp-wall. This gateway is arched at top, where a machicoulis defense may also be arranged to guard the outlet on the exterior. See *Communications* and *Gate*.

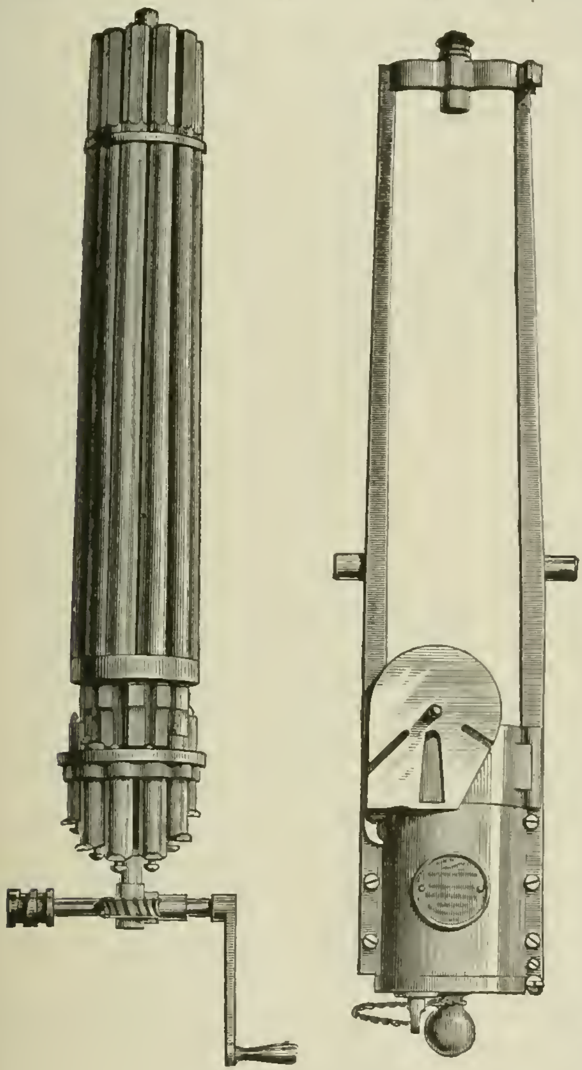
GATLING GUN.—Among the many important and valuable inventions in fire-arms, of which the present century has been prolific, there is none that equals the Gatling gun in originality of design, rapidity of fire, and effectiveness. The severest tests and trials, and its practical use in warfare, have indisputably established its high reputation as a most formidable death-dealing weapon. Trials of the gun have been made from its invention to the present day by the military authorities of the United States, by Mexico, by every Nation of Europe (except the Greeks and Belgians), by several of the South American States, by Egypt, and by China and Japan. These trials have made the gun well known, and its position as an important part of the armament of modern armies is now well assured. Besides, the gun has been formally adopted as an auxiliary service-arm in many of the countries mentioned. The gun was first introduced to European Governments in 1867. At this time the manufacture of metallic cartridges was in its infancy, and the ammunition furnished for the gun was necessarily imperfect. With this imperfect ammunition and with guns that had not the important improvements made during the last few years, the early trials were conducted. The new-model gun and the cartridges recently improved work perfectly, and commend themselves to the critical examination and highest consideration of Governments. The accompanying drawing represents the improved Gatling gun and feed-magazine. This new feed is positive in its action, and by it the gun can be fired, at the rate of 1200 shots per minute, at *all* degrees of elevation and depression. These results have never been attained by any other fire-arm, and will be noticed in detail farther on.

The gun consists of a number of very simple breech-loading rifled barrels grouped around and revolving about one shaft to which they are parallel. These barrels are loaded and fired while revolving, the empty cartridge-shells being ejected in continuous succession. Each barrel is fired only once in a revolution, but as many shots are delivered during that time as there are barrels, so that the ten-barrel Gatling gun fires ten times in one revolution of the group of barrels. The action of each part is therefore deliberate, while collectively the discharges are frequent. The working of the gun is simple. One man places one end of a feed-case full of cartridges into a hopper at the top of the gun, while another man turns a crank by which the gun is revolved. As soon as the supply of cartridges in one feed-case is exhausted, another case may be substituted without interrupting the revolution or the succession of the discharges. The average number of barrels composing the gun is ten. The bore of every barrel extends through from end to end, and the breech is chambered to receive the flanged center-fire metallic-case cartridge. The breech ends of all the barrels are firmly screwed into a disk or rear barrel-plate, which is fastened to the shaft, and the muzzles pass through another similar disk, called front barrel plate, on the same shaft. The shaft is considerably longer than the barrels, and projects beyond the muzzles, and also extends backward for some distance behind the breeches of the barrels. Directly behind the open barrels a cylinder of metal, called a carrier-block, is fastened to the shaft, and in the exterior surface of this carrier-block ten semi-cylindrical channels are cut, which form trough-like extensions of the cartridge-chambers of the barrels to the rear, and are



The Improved Gatling Gun and Feed-magazine.

designed to receive and guide the cartridges while they are thrust into the barrels, and to guide the empty cases while they are withdrawn. Behind the carrier-block the shaft carries another cylinder, called the lock-cylinder, in which ten guide-grooves are formed, which are parallel to the barrels, and in which slide ten long breech-plugs or locks, by which the cartridges are thrust into the barrels, and which close the barrels and resist the reaction of the charges when they are fired. Each plug or lock contains a spiral main-spring acting on a firing-pin, by which the charge is fired, so that the plug performs all the functions of a gun-lock, as well as of a breech-plug. The shaft, to which the group of barrels and both the carrier-block and the lock-cylinder are rigidly attached, is free to turn on its axis, the front end being journaled in the front part of the frame, and the rear end in a diaphragm in the breech-casing. The breech-casing extends to the rear far enough to contain not only the diaphragm through which the main shaft is journaled, but also to form in the rear of the diaphragm a cover for the gearing by which the shaft is revolved. This mechanism or gearing consists simply of a toothed wheel fastened to the shaft and worked by an endless screw on a small axle which passes transversely through the case at right angles to the shaft, and is furnished outside the case with a hand-crank. A cascabel-plate closes the end of the case. Each lock carries a hooked extractor, which snaps over and engages the cartridge-flange when the lock is pushed forward, and which, when the lock retreats, withdraws and ejects the empty case. The cartridge carrier-block is covered above the frame by a semi-cylindrical shell, which is provided at the top with an opening of suitable size and shape to permit a single cartridge to fall through it into one of the channels of the carrier-block, which it overlies. There is a trough extending upward from this opening and forming a hopper, in which a straight feed-case can be placed in a vertical position, containing a number of cartridges lying lengthwise across the case, one above another. Beneath the carrier-block everything is open so as to allow the cartridges or shells which are withdrawn by the extractors from the barrels to fall to the ground. Within the cylindrical breech-case attached to the frame a heavy ring not quite the length of the lock-cylinder is fastened to the case and diaphragm, which nearly fills the space between the inside of the case and the cylinder. Portions from the inside of this ring are so cut away as to leave a truncated, wedge-shaped, annular or spiral cam projecting from the inner surface of the ring, having two helicoidal edges inclined to each other and united by a short, flat plane. Against these edges the rear ends of the locks or breech-plugs continually bear, there being room enough for the locks to lie loosely within the parts of the ring which are cut away. The apex of the wedge-shaped cam points to the barrels. Each lock is held back against the cam by a lug or horn, projecting laterally from the end of the lock, and entering a groove made at the base of the cam, in the thin part of the ring.



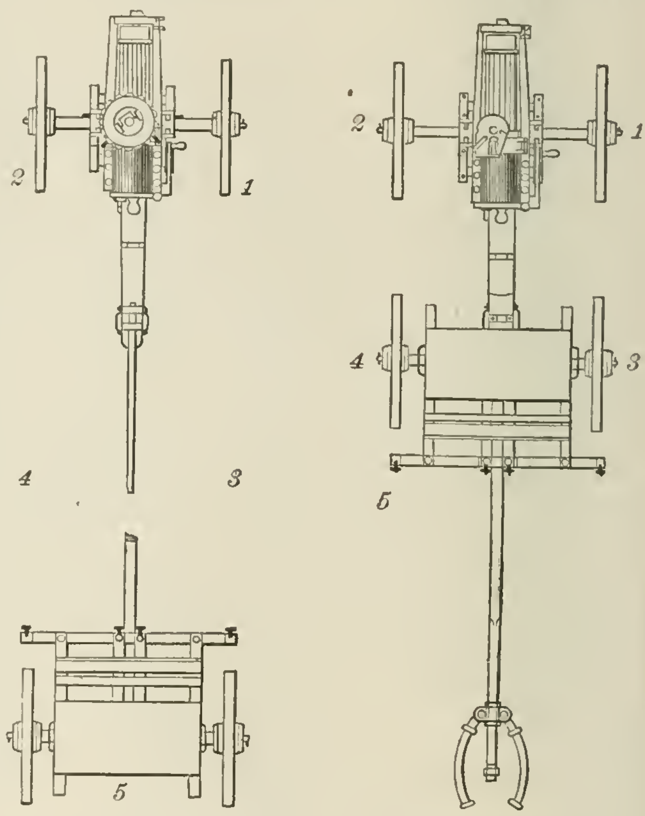
Barrels, Shaft and Casing.

The distance of the apex of the cam from the ends of the barrels is such that the breech-plugs or locks exactly fill the space, so that each plug there forms an abutment, which closes the breech of its barrel and abuts against the apex of the cam, which serves to resist the recoil of the plug when the charge is fired. It will be remembered that the locks are guided in grooves formed in the lock-cylinder, and therefore cannot deviate from their alignment with the barrels. From what has before been explained it will be understood that the ten barrels, the cartridge carrier-block, and the lock-cylinder carrying its ten locks, will, by turning a crank, revolve together about the axis of the central shaft, the lock-cylinder revolving within the stationary case and cam-ring, and the cartridge carrier-block revolving beneath the half-cylindrical shell which carries the hopper. The cartridges will, as the carrier-block channels come successively under the hopper, drop into the channels in front of the locks, and be kept in place by the hopper-shell. The revolution of the lock-cylinder carries the locks around with it, and causes them to receive a longitudinal reciprocal motion, by their ends sliding along the inclined surfaces of the stationary cam. Each lock, then, one after the other, is pushed forward toward its barrel. As the revolution of the parts keeps the locks in contact with the advancing side of the cam, each lock in succession closes its barrel, and its longitudinal motion ceases, while it passes the flat surface to the cam, and then each slides backward from its barrel when constrained to move along the retreating side of the cam by the corresponding cam-groove, and so on, each lock repeating these movements at each successive revolution of the shaft.

The position of the cam relatively to the cartridge-hopper is such that each lock is drawn backward to its full extent when it passes the hopper, so that the cartridges may fall into the carrier in front of the locks. The explosion of each cartridge takes place as its particular lock passes over the flat apex of the cam which resists the recoil.

The hammer is cocked by the knob or head at its rear end coming into contact with a flat *rib* located inside of the cam. This rib restrains the hammer from moving forward, while the forward movement of the body of the lock continues; the spiral mainspring is compressed until the revolution carries the hammer-knob beyond the end of the cocking-rib, when the hammer will spring forward, and strike with its point the center of the cartridge-head, and explode the charge. The point in the revolution at which the barrels are discharged is below and at one side of the axis. Thus it will be seen that, in the ten-barrel gun, one revolution of the barrels corresponds to one revolution of the locks, and delivers ten shots; a process which is repeated continuously, so long as the crank is turned and the cartridges are supplied. The gun can be unloaded of any cartridges not fired by removing the feed-case, opening the hopper, and reversing the motion of the crank. The locks are made interchangeable, and are strong and durable, but should they get out of order the gun is so constructed that any one or all of them can be in a few moments taken out and others inserted in their places, and so the gun can be kept in perfect working order at all times on the field of battle. In the new model the mechanism of the locks has been greatly strengthened as well as otherwise improved, and there are means at hand for their insertion and removal without taking off the cascabel-plate. These means consist of the perforation of the covering and back diaphragm in the outer casing, and by the closure of the apertures through both these plates by a single removable plug.

This is a very valuable improvement, inasmuch as the repairing or inspection of the locks is thereby greatly facilitated. The absence of one or more locks does not affect the working of the gun, except to diminish the intensity of fire in proportion to the number of locks removed. For each lock removed, however, one unexploded cartridge falls to the ground at each revolution of the gun. The gun is encased in a frame which has trunnions, and is mounted in the ordinary way, like a field-piece. The screw for elevating and depressing the breech works in a nut attached to the rail of the carriage in the usual way. An automatic traversing apparatus is applied by which a limited angular movement in a horizontal plane may be given to the gun, as follows: A cylinder having a cam-groove in its periphery is applied to the crank-axle, and the end of a cylindrical pin enters this groove. The cylindrical pin is attached to an arm which is connected to the elevating-screw; when the crank is turned the cam-groove travels back and forth on the cylindrical pin, swinging the gun from side to side through a sector of three degrees. The pin may be thrown out of gear with the cylinder and the gun be fired without swinging. The sector, covered automatically by the traverser, may be changed about five degrees on each side without moving the trail or suspending the firing. The cases which contain the cartridges, and which are applied to the hopper when it is desired to feed the gun, are long narrow boxes of sheet-tin reinforced by gun-metal, open only at the lower ends. The cross-section of the case is trapezoidal, the edge next to which the heads lie being wider than the cartridge-heads, while that which receives the points of the balls is of the width of the ball. This form enables all the cartridges in the case to assume a horizontal position, because the heads of the contiguous cartridges have room to roll over slightly, so as to lie partly alongside of each other, while the ball-ends are kept vertically over each other. Above the cartridges in the case is a weight which can be moved up and down by a thumb-piece. By the action of the hand pressing on the thumb-piece any desired pressure, regulating the rapidity of feed, can be given to the cartridges. Each straight feed-case holds just forty cartridges. The supply of cartridges to the gun may also be made by what is called the feed-drum (used only with the smaller calibers). This contains sixteen radial sections grouped vertically about the axis of the drum. Each section holds twenty cartridges, or each drum holds three hundred and twenty cartridges. The number of sections in the drum and the number of cartridges in each section may be varied. The drum rests vertically over the hopper, and feeds the cartridges automatically from the several sections in succession. Five men, including the gunner, are necessary for the service of the piece. With a greater number of cannoneers an exceptionally rapid and continuous fire can be sustained by assigning more men to the duties of exchanging empty for full feed-cases, and bringing up ammunition; but it is advisable not to expose too many men around the gun to the enemy's fire. The detachment may be maneuvered by the usual commands and means.

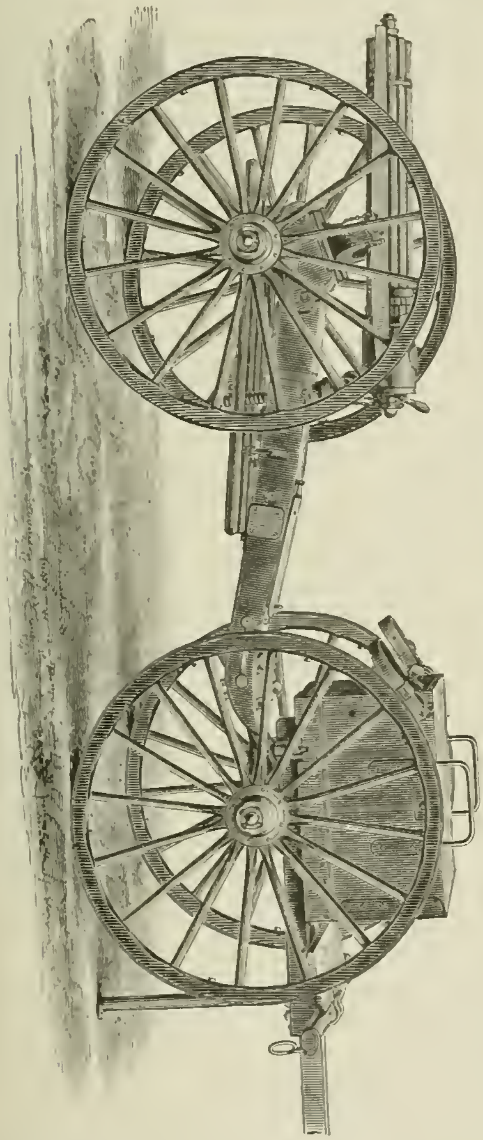


Posts of Cannoneers.

The cannoneers are numbered from *one* to *five*, and their posts at the piece unlimbered will be as follows: Nos. 1 and 3, on the right flank of the piece—No. 1 opposite the cascabel, and No. 3 opposite the rear end of the handspike; Nos. 2 and 4, on the left flank of the piece—No. 2 opposite the cascabel, and No. 4 opposite the rear end of the handspike; No. 5, is in rear of the limber-chest,—all facing to the front. Nos. 2, 4, and 5 wear haversacks slung from the left shoulder.

As soon as the piece is unlimbered, No. 1 ungears the crank and sees that it works easily. No. 2 sees that the hopper is clear for the insertion of a feed-case. No. 3 places the handspike, gets the traversing apparatus in action, and points the piece in the general direction required. Nos. 2, 4, and 5 go to the limber and place five filled feed-cases in their haversacks. After these duties are performed, all resume their positions.

At the command LOAD, No. 1 steps in to the crank, takes hold of the handle with his right hand, and is ready to turn the crank. No. 2 steps in and places a feed-case in the hopper, grasping it with his left hand



Gatling Gun. Carriage and Limber.

on the top, taking hold of the weight-stud with his right hand, so that he can gently press on the cartridges as they move, keeping the case perpendicular to the line of the bore. No. 3 seats himself on the trail-seat and sees that the gun is properly pointed. Nos. 4 and 5 stand fast. At the command FIRE, No. 1 turns the crank regularly without jerks. No. 2 attends the feed-case on the gun, seeing that it feeds regularly, withdrawing the empty case, and replacing it with a filled one, until he has inserted his last filled case in the hopper. He then calls out "case," when No. 4 steps forward and replaces the empty feed-cases with filled ones, and removes the empty ones. He then takes the empty cases to the limber, exchanges them for filled cases, or refills them as may be necessary, and places five filled cases in his haversack, and stands fast, when No. 4 steps forward to No. 2. No. 5 steps forward to the position just left by No. 4, and when No. 2 again calls "case," he performs the same duties that have just been designated for No. 4, and Nos. 4 and 5 perform these duties in succession during the continuance of the firing. No. 2 may drop the empty feed-cases on the ground, or place them in his haversack, taking care to have an uninterrupted flow of cartridges into the hopper kept up. At the command CEASE FIRING, No. 2 withdraws the feed-case from the hopper, places it in his haversack, and resumes the position which he had before the command LOAD was given. No. 1 turns the crank until the cartridges in the hopper have been fired, and then resumes his original position. No. 3 takes his original position, after No. 1 has stopped turning the crank. Nos. 4 and 5 stand fast, unless they are moving at the time the command is given, in which case they take care that No. 2 has five filled feed-cases in his haversack, and then resume their original positions. Should feed-drums be used instead of feed-cases, No. 2 should place the drum on the pintle as soon as the piece is unlimbered. Haversacks will not be worn by Nos. 2, 4, and 5, and when No. 2 gets to feeding from the last compartment of the feed-drum, he will call out "drum," when No. 4 or No. 5, as the case may be, will replace the empty drum, which No. 2 will lift off, by a filled drum, and will at once take the empty drum to the limber to be refilled. At the command CEASE FIRING, when the drum is used, No. 2 will continue to feed until all of the cartridges in the compartment of the drum then in use are exhausted. The methods of limbering and unlimbering, mounting and dismounting of the cannoneers, the intervals between the pieces, service of the piece with reduced numbers, etc., are all dependent upon the Field-artillery Tactics of the Nation using the gun. When the piece is limbered, Nos. 1 and 2 are opposite and one yard outside the naves of the carriage-wheels, Nos. 3 and 4 opposite and one yard outside the naves of the limber-wheels, the gunner in front of the limber-wheel, on the same line with Nos. 2 and 4, who are on the right of the piece, the odd numbers being on the left. The cannoneers are mounted and dismounted as prescribed in Artillery Tactics, except that the gunner and Nos. 1 and 2 mount on the limber of the piece, No. 2 in the middle. In drilling at the school of the piece, in garrison or camp, it will be well to remove the locks to prevent the unnecessary snapping of the springs, and the cartridges can then be run through the hopper at will, familiarizing the men with the use of the gun without waste of ammunition or injury to the locks.

The style of carriage depends somewhat upon the service for which the gun is intended. In the United States an ordinary field-carriage with limber has been used. The drawing shows the musket-caliber, ten-barrel Gatling gun, on carriage with limber complete. Recently a two-wheeled cart, with shafts for a horse, has been proposed by the Ordnance Department, intended to carry the gun and two ammunition-boxes, containing together 40 feed-cases, each holding 40 cartridges, so that the carriage takes with it 1600 cartridges in feed-cases. A space is also reserved in front of the axle for two boxes of cartridges containing 1000 each. The weight of the carriage without cartridges is about 500 lbs. This carriage is intended specially for service with cavalry.

The cartridge for the Gatling gun is made of No. 18 sheet-copper. The *canister* consists of a case terminated at one extremity by a hemispheroid of lead called the head; it contains for the 1-inch gun 15 bullets, .48-inch in diameter. The charge for this gun is ¾ ounce of mortar-powder and 6 grains of fulminate; that for the .50-inch gun is 70 grains of musket-powder and ½ grain of fulminate. The fulminate used is composed of fulminate of mercury, 3 parts;

pulverized niter, 2 parts; glass dust, ½ part; chlorate of potassa, 2 parts. This is well moistened with gum-arabic water.

The *solid shot* consists of a case containing the above composition and charge of powder, with an elongated bullet weighing 8 ounces for the 1 inch, and 450 grains for the .50-inch and .45-inch guns. Canister is only used with the 1-inch gun. The cartridges are put up and issued from the arsenals in pasteboard packages, and when required for service enough are opened to fill the tin feed-cases carried in the limbers of the pieces. The ammunition-chests of the caissons are filled with unbroken packages. For the .45-inch gun the ammunition is interchangeable with that for the regulation infantry rifle.

The character of the rifling of Gatling guns is uniform groove, making one turn in 72 inches for the 1-inch gun, one turn in 42 inches for the .50-inch, and one in 22 inches for the .45-inch gun. The effective range is contemplated at from 200 to 1200 yards, or the zone of infantry fire.

The Gatling gun has recently undergone a great improvement, both in the matter of its details and in its feed. The drawing at the head of this article represents one of the improved guns, having six, eight, and ten barrels, each barrel having its corresponding lock. The barrels and locks revolve together, inside the outer stationary case. But in addition to this action, the locks have a forward and backward motion of their own. The forward motion places the cartridges in the chambers of the barrels and closes the breech at each discharge; while the backward motion extracts the empty cartridge-case after firing. The cartridges are supplied to the gun by magazines consisting of a circular drum of a width slightly greater than the length of the cartridge. On the two circular plates which form the ends of the drum are spiral grooves running from the center to the outer edge, in which the ends of the cartridges are supported and guided in and out of the magazine. In the center of the magazine, between the two aforesaid grooved plates, are two other circular plates which revolve round the central shaft, having a number of slots radiating from the center, and joined near the outer edge by pins. These two plates when revolved force the cartridges along the aforesaid grooves in the end plates out of the magazine into the receiver of the gun, and in front of the locks. The center plates of the magazine are revolved by projections on the receiver which engage with pins that join the center plates in the form of gear. The magazine is held in its place over the receiver by flanges on each side of the hopper with two under-cut slots in which two projections on the magazine fit so as to lock it in its place. The slots are of unequal size, so that the magazine cannot be wrongly inserted. On the left-hand side of the hopper are two wedge-shaped points that are let down into the receiver, which eject the empty shell from the receiver when extracted from the chambers by backward motion of the lock. The extractor is so formed that its hook remains always in front of the cartridge-head, and it is rendered stronger by making it double its former width circumferentially. It has no spring and does not lift the lock by springing over the cartridge-head. The cartridge is therefore always struck centrally instead of at the side. The extractor is so arranged that after each discharge it holds back the firing-pin so that its point does not project in front of the lock-face until released by the cocking-ring, making it impossible for a premature explosion of the cartridge to take place by the forward motion of the lock coming in contact with the cartridge-heads. In firing at high elevations, the cartridges are prevented from sliding back into the mechanism through the orifice in the front lock-flange, either when the locks are in or out of the gun, by flanging the openings and making the lock to correspond. The gun has been fired in a vertical position with as much ease and perfection as when horizontal. The rear portion of the lock is supported by a T-way at the center instead of at the bottom, in order to prevent all possibility of jamming by dust or sand. The gun is mounted on trunnions two inches below the center, and is elevated and depressed by means of a circular elevating arc connected at both extremities with the gun, and actuated by gearing so arranged that elevation and depression are indicated in degrees and minutes. A horizontal limb for direction is graduated in the same way. Both kinds of gear are so arranged that they can be instantly thrown out, allowing the gun to move rapidly in all directions by means of a long lever. The automatic oscillator is dispensed with, the effect being produced by hand movement of the rear lever. An adjustment of the lateral training is obtained by means of stops on the turn-table of the carriage, which can be set to any required number of degrees. The gun can be elevated to 74 degrees and depressed to 78 degrees. It is provided with two sights, viz., one on each side. A device is added to serve the purpose of throwing the cocking-ring out of use at will, and prevents the cocking of the firing-pins. This is of advantage during drill, and allows firing motion to take place without snapping and thereby injuring the firing-pins. The barrels are locked into the rear flange-plate instead of being screwed as heretofore. In case of accident to lock or barrel the lock can be instantly removed, and the firing continued with the remaining locks.

The gun can be fired with the crank either at the rear or side. When at the side, the gun fires at each turn of the crank about one half the number of shots to the number of barrels in the gun; when at the rear, it fires at each turn of the crank as many shots as there are barrels in the gun. The feed-magazines hold from 65 to 104 cartridges each, and weigh from 10 to 24½ lbs. when full of cartridges. The musket-caliber guns weigh from 100 to 237 lbs. each, according to the number and length of the barrels.

It is believed that the best organization for Gatling guns is that of the battery in field-artillery, and that the batteries should belong to the division rather than to a smaller organization. Circumstances may arise that will make the use of the guns in batteries of six or eight pieces enormously valuable; but in any event, better care can be taken of the guns, better instruction given to the men, and a better discipline and *esprit de corps* kept up by a battery organization than by distributing them singly or in sections to serve with infantry regiments. Before any action, the batteries could, if necessary, be assigned to brigades, and the pieces could be used at the discretion of the Commanding General in field-works, trenches, to guard, or drive the enemy from hollow roads, fords, bridges, and ravines, or to assist infantry in holding exposed positions. For detailed description of parts, see the appropriate headings. See *Camel-gun* and *Machine-gun*.

GAUGE.—An apparatus for measuring any special force or dimension; thus we have *pressure-gauge, wind-gauge, rain-gauge, wire-gauge*, etc. The simplest form of gauge of dimension is the common *wire-gauge*, by which the diameter of wire is measured. It is simply an oblong plate of steel, with notches of different widths cut upon the edge; these are numbered, and the size of the wire is determined by trying it in the different notches until the one is found which it exactly fits. The thickness of sheet-metal is tried by the same gauge. There is a great want of uniformity in all these gauges—the Birmingham gauge for iron wire, sheet-iron, and steel differing from that used for brass, silver, gold, etc., and these, again, from the Lancashire gauges. It has been proposed, in order to obtain uniformity, and to enable definite descriptions and orders to be given with accuracy and certainty, that instead of the arbitrary numbers of varying signification now in use, decimal parts of an inch, tenths, hundredths, thousandths, or still smaller fractions, if necessary, be used, and that these be used for all diameters and thicknesses, such as wires, sheet-metals, buttons, watch-glasses, etc.; but such a scale has not yet come into general use. The gauge commonly used for large diameters is a rule with a groove cut lengthwise down the middle. Another metal rule, with a brass head, slides in this, and by means of a thumb-pin may be pushed out at pleasure. The object to be measured is placed between the inside of the slide and the end of the rule, and the width of this space is measured by graduations on the middle metal slide. The engraving shows a combination of sizes known as step-gauges. This device is very valuable for general use in the arsenal and armory, for testing holes, adjusting calipers, etc. They are made in sets of any number of gauges, as may be desired for the particular kind of work. The width of the disks increases with their diameter. A very elegant and delicate gauge has recently come into use for measuring watch-glasses, and is applicable to many other purposes. On an oblong piece of sheet-metal two straight metal ridges are fixed in such a manner that they shall be inclined at a given angle to each other. Now, let us suppose the angle to be such that the distance between the upper extremities is 2 inches and that between the lower ends is 1 inch, while the lengths of the metal ridges are 10 inches. It is evident that for every inch of descent from the upper to toward the lower ends there will be a narrowing equal to $\frac{1}{10}$ of an inch; and for every tenth of an inch of such descent there will be a narrowing of $\frac{1}{100}$ of an inch, and so on: thus we may, by graduating downwards from the top, measure tenths by units, hundredths by tenths, and so on to still finer quantities if required. This is applicable to lengths as well as diameters. By means of fine screws with large graduated heads Messrs. Whitworth have measured small pieces of steel to the one-millionth of an inch. See *Anemometer*, *Calipers*, *Corrective Gauges*, *Micrometer*, *Pressure-gauge*, *Star-gauge*, and *Wire-gauge*.

Step-gauges.

GAUNTLET.—Armor for the hand and arm, made either of scales or mail, and used in the Middle Ages. It formed part of the armor of knights and men-at-arms. See *Gantlet*.

GAUTIER TELEMETER.—This telemeter, invented by Captain Gautier, of the French army, is an instrument for measuring, with a great degree of approximation, any difference, not exceeding three degrees, which may be exhibited in the bearing of a distant object by viewing it from different points of a base-line transverse to its general direction from the observer. The instrument, in its simplicity, accuracy, and portability, recommends itself in all cases where a knowledge of distances is desired at any moment and with the least possible delay; such, for instance, as range-finding, river-crossing, reconnoitering, and the like. A slight acquaintance with its use on such occasions enables the observer to estimate, with more than ordinary promptitude and precision, the distance which it might be all-important to obtain. The instrument, shown in Fig. 1, resembles in

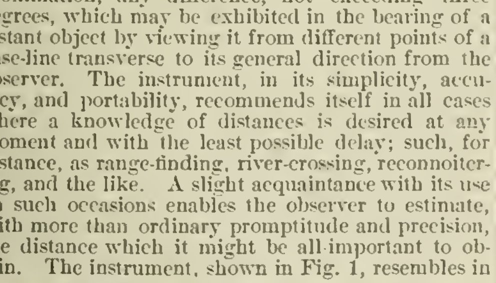


Fig. 1.

shape and size one barrel of an ordinary reconnoitering or field glass. The case in which it is carried is fashioned so as to answer as a handle for holding the instrument when making observations. Within the barrel of the instrument are placed two mirrors at an angle of about 45 degrees with each other; this angle can be varied within certain limits by means of a milled-headed screw acting on one of them. The mirrors are thus made to operate upon the principle of the sextant. A slot on one side of the barrel permits the rays of light from an object to fall upon one of the mirrors, from whence they are reflected upon the other mirror, and the image is seen through the eye-glass at the small end of the instrument. At the front or large end is fixed, in a ring surrounding the barrel, a prism, whose displacement modifies the direction of any object seen through it. At the rear of the instrument is a small eye-glass, by means of which the observer sees, *over* the mirrors and through the prism, the object which is before him, and by double reflection *in* the mirrors the object to the side of him. The semi-revolution of the movable ring containing the prism corresponds to a displacement of the object toward the left of about three degrees. The ring is provided with a graduated scale containing numbers, the use of which will be explained.

Suppose C, in Fig. 2, to be the object, and A the point from which the distance A C is to be determined. Select some distant object, as M, for the *signal*, the direction A M to it making with the line A C an angle a little greater than 90 degrees. From the point A measure the base, A B, in the prolongation of the line to the *signal*. After having adjusted the telemeter upon the case, which serves as a vertical handle, turn the ring until the word "infinity" is brought opposite the fixed index or arrow. This brings the prism to its *initial position*. A small opening in the under part of the instrument, exhibiting the mirror index, enables the observer to assure himself that the movable mirror is at its *mean position*, which is indicated by a fixed mark. The telemeter is then ready for operation, and the observer places himself at A, so that the object C will be on his right. (The right is here chosen merely for purpose of illustration. The observation can be as easily made with the object on the left.) The instrument is held in the left hand, the fingers of which clasp the barrel firmly to the handle (the case). The observer, facing the signal M and sighting through the eye-glass upon the signal, turns, with the right hand, the milled screw until the image of the object C coincides with the signal M. Leaving the screw in this position, he retires to the other end, B, of the base-line, where, holding the instrument as before, he sights upon the signal, and turning the graduated ring on the front end, makes the images again coincide. This done, there will be found on the ring opposite the fixed index a number which, being multiplied by the number of units in the base-line, will give the required distance A C in terms of the unit used in measuring the base. This is the method of a *fixed base*. Another method is by means of a *proportional base*, which is, instead of measuring a base as just described, a certain factor is selected on the ring and the instrument set to it; then by moving back in the direction A B until the images coincide, the distance thus moved over will be the base, which is then measured and multiplied by the selected factor. This method has the advantage of eliminating the errors of reading the movable ring.

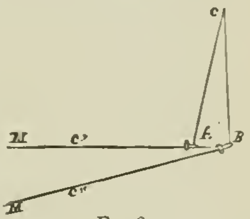


Fig. 2.

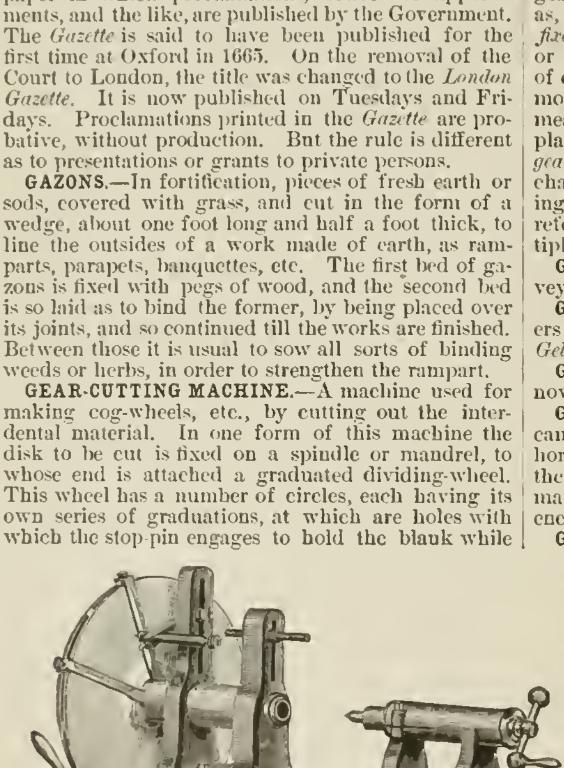
A base of $\frac{1}{100}$ of the distance suffices in general for obtaining the exactness of measurement required in military operations. It is necessary always that the object and the signal be well defined and of a convenient form and size, and that the observer be sufficiently skilled with the instrument to make with precision the necessary sightings, and to make the proper alignment of the two stations upon the signal. In a case where a good natural signal is found, distances up to 2000 meters can be readily measured in less than two minutes. If the conditions are less favorable, the measurements may be effected by employing bases of $\frac{1}{50}$ or of $\frac{1}{30}$. Whatever be the method employed, the immediate result of the operation is the knowledge of the relation between the distance sought and the base. The base may be expressed according to any unit of measurement, and the distance will be correspondingly expressed. If the base is measured in yards, the distance will be yards, etc. See *Telemeter.*

GAZE.—A term in Heraldry. When a beast of the chase, as a hart or stag, is represented as *affrontée*, or full-faced, it is said to be at gaze.

GAZETTE.—A gazette was a Venetian coin worth somewhat less than a farthing; and the name was hence applied to a sort of gossiping sheet, or primitive newspaper, that was sold for that sum at Venice. In its English acceptation it means the official newspaper in which proclamations, notices of appointments, and the like, are published by the Government. The *Gazette* is said to have been published for the first time at Oxford in 1665. On the removal of the Court to London, the title was changed to the *London Gazette.* It is now published on Tuesdays and Fridays. Proclamations printed in the *Gazette* are probative, without production. But the rule is different as to presentations or grants to private persons.

GAZONS.—In fortification, pieces of fresh earth or sods, covered with grass, and cut in the form of a wedge, about one foot long and half a foot thick, to line the outsides of a work made of earth, as ramparts, parapets, banquettes, etc. The first bed of gazons is fixed with pegs of wood, and the second bed is so laid as to bind the former, by being placed over its joints, and so continued till the works are finished. Between those it is usual to sow all sorts of binding weeds or herbs, in order to strengthen the rampart.

GEAR-CUTTING MACHINE.—A machine used for making cog-wheels, etc., by cutting out the interdental material. In one form of this machine the disk to be cut is fixed on a spindle or mandrel, to whose end is attached a graduated dividing-wheel. This wheel has a number of circles, each having its own series of graduations, at which are holes with which the stop-pin engages to hold the blank while



Gear-cutting Attachment.

the circular cutter on the slide-rest does its work. This cutter has a shape coinciding with that of the interdental space of the wheel required. The mandrel of the cutter-wheel is rotated by a band, and the cutter is fed by a hand-crank and feed-screw, so as to traverse past the face of the wheel under treatment. The drawing shows the gear-cutting attachment to the milling-machine, used in armories for cutting larger and heavier wheels than can be cut with the ordinary apparatus. It swings 13 inches, and is supplied with a 20-inch index which contains 4294 holes. It will divide all numbers to 75, and all even numbers to 150.

GEARING.—1. Warlike accouterments; military harness and apparatus for lifting and training heavy ordnance; equipage. 2. A term applied to the parts of machinery by which motion in one part of a machine is communicated to another; gearing consists in general of toothed-wheels, friction-wheels, endless bands, screws, etc., or of a combination of these. When the communication between the two parts of the machine is interrupted, the machine is said to be *out of gear;* and when the communication is restored, it is said to be *in gear.* In the case of the grinding-mill, e.g., driven by a steam engine, the gearing usually consists of an endless band which communicates motion from the axle of the fly-wheel to that of the drum. If the band were slipped off from one wheel, or slackened so that motion could not be communicated by means of it, then the machine would be *out of gear.* Gearing which can be placed in and out of gear is called *movable gearing;* that which cannot, as, for instance, the wheel-work of a watch, is called *fixed gearing.* Gearing which consists of wheel-work or endless screws is put out of gear either by means of one of the wheels sliding along its axis, or being moved out of its place horizontally or vertically by means of a lever. *Straight gearing* is used when the planes of motion are parallel to each other; *beveled gearing,* when the direction of the plane of motion is changed. Gearing has also for its object the increasing or diminishing of the original velocity, and in reference to this is distinguished by the term "multiplying" or "retarding."

GEAT.—The hole through which the metal is conveyed to the mold in casting ordnance. See *Casting.*

GEBEGIS.—A term formerly applied to the armorers among the Turks. It is now nearly obsolete. See *Gelibach.*

GEBELIS.—A Turkish corps of picked men, renowned for their perseverance and fighting qualities.

GEBELUS.—Every Timariot in Turkey, during a campaign, is obliged to receive a certain number of horsemen, who are called *Gebelus,* and to support them at his own expense. He is directed to take as many as would annually cost 3000 *aspres* for subsistence.

GELIBACH.—A sort of Superintendent or Chief of the *Gebegis* among the Turks. He is only subordinate to the Toppibachi, or the Grand Master of the Turkish artillery.

GEMOTE.—Besides the great Council of the Nation—the *Witena-gemot,* or, as we more usually spell it, the Witenagemót—which corresponded to the Reichstage of the Franks, and which, though it took the place of the still more ancient meetings of the whole Nation, to which Tacitus refers as characteristic institutions of the Teutonic tribes in his day, was a representative, though not perhaps an elective body, there were amongst the Anglo-Saxons numerous minor motes or moots, which did not take part of the representative character. The existence of these is an instance of the manner in which the spirit of localization has always maintained its ground, and balanced that of centralization amongst the Germanic Nations, and more particularly in England. There was the *Shiregemot,* or County Court, which met twice in a year; and the *Burg-gemot,* which met thrice; also the *Hundred-gemot,* which met every month, and an extraordinary meeting of which was held twice a year; the Hallegemote, or *Court-baron.* These institutions excluded not only central despotism, but local tyranny in the shape of individual caprice. The Ealdorman decided only with the assent of the Shire-gemote, just as the King was dependent upon that of the Witan. (Lappenberg by Thorpe, ii. p. 322.)

GENDARMES—GENS D'ARMES.—Originally, and up to the time of the first French Revolution, the most distinguished cavalry corps in the service of the Bourbon Kings, to whom they formed a sort of body-guard. Under existing arrangements, the Gendarmes constitute a military police, and comprise both cavalry and infantry. The force consists principally of soldiers taken from the army, generally on account of intelligence and good conduct. The men receive much higher pay than the rest of the army, of which, however, the corps is a part, and they are liable in cases of emergency to be sent on active service. The Gendarmes amount to about 27,000 men, and are intrusted with the execution of many of the most delicate details of government.

GENERAL.—1. A term for the roll of the drum which calls the troops together. To "beat the general" is a phrase drawn from the French drum-instructors, *Battre la générale*.—2. The highest military title in the United States army until very recently, and the highest military title below that of Field Marshal in European armies. A General ordinarily commands no body of men less than an army. See *General Officer*.

GENERAL COURT-MARTIAL.—In the army, a tribunal for the general examination and punishment of offenders against martial law, or against good order and discipline.

The following is a form of record for a General Court-Martial:

Page 1. CASE 1.

PROCEEDINGS OF A GENERAL COURT-MARTIAL WHICH CONVENED AT ——, ——, PURSUANT TO THE FOLLOWING ORDER:

HEADQUARTERS DEPARTMENT OF —— ——,
——, ——, 187 .

Special Orders }
No. —. }

[EXTRACT.]

A General Court-Martial is hereby appointed to convene at ——, on —— the —— of —— at 10 o'clock A.M., or as soon thereafter as practicable, for the trial of such persons as may be brought before it by authority from these Headquarters.

Detail for the Court.

1. Colonel —— ——, —— Artillery.
2. Major —— ——, —— Cavalry.
3. Surgeon —— ——, U. S. Army.
4. Captain —— ——, —— Infantry.
5. Captain —— ——, —— Artillery.
6. Captain —— ——, —— Infantry.
7. Assistant Surgeon —— ——, U. S. Army.
8. First Lieutenant —— ——, —— Infantry.
9. First Lieutenant —— ——, Ordnance Dep't.

First Lieutenant —— ——, —— U. S. Artillery, is appointed Judge Advocate of the Court.

No other officers than those named can be assembled without manifest injury to the service.

By command of Major General ——:

—— ——,
Assistant Adjutant General.

Page 2. CASE 1.

—— BARRACKS,
——, ——,
——, 187 .

The Court convened, pursuant to the foregoing order, at 10 o'clock A.M.

Present:

1. Colonel —— ——, —— U. S. Artillery.
2. Major —— ——, —— U. S. Cavalry.
3. Surgeon —— ——, U. S. Army.
4. Captain —— ——, —— U. S. Infantry.
5. Captain —— ——, —— U. S. Artillery.
6. Captain —— ——, —— U. S. Infantry.
7. Assistant Surgeon —— ——, U. S. Army.

First Lieutenant —— ——, —— U. S. Artillery, Judge Advocate.

Absent:

1. First Lieutenant —— ——, —— U. S. Infantry.
2. First Lieutenant —— ——, Ordnance Dep't.

(Here set forth the cause of absence of any absent member, if the same is known. It is the duty of the Judge Advocate to ascertain, if possible, the cause of absence and record it, and in cases of sickness medical certificates should generally, when practicable, be furnished by the absent members, and appended to the record.)

The Court then proceeded to the trial of —— ——, —— Regiment U. S. Infantry, who thereupon came before the Court, and having heard the order convening it read, was asked if he had any objection to any member present, named in the order: to which he replied in the negative, [or, the Accused (*or* Prisoner, *as the case may be*) submitted the following objection to —— ——].

(Here insert the objection.)

The challenged member stated that:

(Here insert the statement of challenged member.)

The Court was thereupon closed, the challenged member and the Prisoner retiring, and, after due deliberation, the Court having reopened, the challenged member and the Prisoner resumed their seats, and the decision of the Court was announced by the Judge Advocate that the objection of the Prisoner is sustained, and [Here insert challenged member's name and rank] is therefore excused from serving as a member of the Court in this case; [or, that the objection of the Prisoner is overruled].

(Objection can only be urged to one member at a time, for cause stated to the Court, and a record as above must be made in each instance. If the person on trial has no objection to offer, the record will continue as follows:)

The members of the Court were then severally duly sworn by the Judge Advocate, and the Judge Advocate was then duly sworn by the President of the Court: all of which oaths were administered in the presence of the Prisoner, or Accused.

(The oaths are given in the 84th and 85th Articles of War. Should the person on trial desire to introduce counsel, he should now make application, and the record will continue as follows:)

The Prisoner now requested permission of the Court to introduce —— —— as his Counsel, which request was granted.

(The Counsel for Prisoner, when needed by him to assist in an objection to a member or examination on the *voire dire*, may be introduced to the Court immediately after reading the order appointing it. The practice of all Courts-Martial is to receive as Counsel any officer of the army or any lawyer in good standing, or other competent person, but Courts-Martial may, like the Civil Courts of the United States of criminal jurisdiction, decline to receive any individual as Counsel who, by reason of character or ignorance, would, in the Court's judgment, be an improper person to appear before it. In such case the record should state the reasons. If any delay in the trial is desired, application should now be made, and in passing upon the request the Court should be governed by the 93d Article of War.)

The Prisoner was then duly arraigned upon the following charge and specification:

Charge: —— —— —— —— ——

Specification: —— —— —— —— ——.

To which the Prisoner pleaded as follows:
To the specification: "Guilty" [*or*, "Not Guilty"].
To the charge: "Guilty" [*or*, "Not Guilty"].

(Or the Prisoner may, in lieu of pleading to the merits, put in a plea in bar of trial—to the jurisdiction, or special plea, such as autrefois acquit or convict, pardon, on which the Court will have to pass.)

Captain —— ——, of the —— U. S. Infantry, a witness for the prosecution, then came before the Court and was duly sworn by the Judge Advocate, and testified as follows:

(The oath is given in the 92d Article of War.)

Question, by the Judge Advocate: * * * *
Answer: * * * * * *

CROSS-EXAMINATION.

Question, by the Prisoner: * * * * *
Answer: * * * * * * *
* * * * * * * *

(If the person on trial declines to cross-examine the witness, it should so appear on the record. If new matter has been elicited in the cross-examination, bearing upon the issue of the trial, the Judge Advocate may re-examine the witness, should the facts require it. After the examination-in-chief, the cross-examination and re-examination, the Court can ask such questions as it may deem necessary. A question by a member of the Court, if objected to and rejected, must be recorded as "by a member." If not objected to, the record will continue as follows:)

Question, by the Court: * * * * *
Answer: * * * * * *
* * * * * * * *

(After all the testimony for the prosecution has been adduced, the record will continue as follows:)

The Judge Advocate then announced that the prosecution rested.

The Court then, at — o'clock P.M., adjourned to meet to-morrow at 10 o'clock A.M.

——— ———.
1st Lieutenant —— *U. S. Artillery*,
Judge Advocate.

SECOND DAY.
—— BARRACKS,
——, ——,
——, 187

The Court met, pursuant to the foregoing order and adjournment, at 10 o'clock A.M.

Present:

(Here give names, rank, etc., of members present and of Judge Advocate in manner stated.)

Absent:

(Names, rank, and cause of absence.)

The Prisoner (and ——— ———, his Counsel) also present.

The proceedings of the —— instant were then read and approved.

Sergeant ——— ———, of the —— U. S. Infantry, a witness for the defense, then came before the Court and was duly sworn, and testified as follows:

Question, by the Prisoner: * * *
Answer: * * * * *
* * * * * *

CROSS-EXAMINATION.

Question, by Judge Advocate: * * *
Answer: * * * * *
* * * * * *

Question, by the Court: * * * *
Answer: * * * * *
* * * * * *

The Prisoner having no further testimony to offer, made the following statement in his defense, [*or*, submitted a written statement in his defense,] which was read to the Court by the Prisoner, [or by his Counsel, or by the Judge Advocate,] and is hereto annexed, marked "A."

(The statement of the Accused, when in writing, or written argument in his defense, and all written pleas in bar of trial or abatement, should be signed by the Prisoner himself and appended to the record, and referred to in the proceedings as having been submitted by him, whether he is defended by Counsel or not.)

The Judge Advocate replied as follows:

(Here insert the remarks of the Judge Advocate, if verbal; if written, they should be read and annexed as in case of the defense; or,)

[The Judge Advocate submitted the case without remark.]

The Court was then cleared and closed for deliberation, and having maturely considered the evidence adduced, finds the Prisoner, ——— ———, —— U. S. Infantry:

Of the specification: "Guilty" [*or*, "Not Guilty"]
Of the charge: "Guilty" [*or*, "Not Guilty"]

And the Court does therefore sentence him, ——— ———, —— of —— Regiment U. S. Infantry, to ——— ———. [*or*, And the Court does therefore acquit him, ——— ———, —— of —— Regiment U. S. Infantry.]

——— ———,
Colonel —— *U. S. Artillery*,
President.

——— ———,
1st Lieut. —— *U. S. Artillery*,
Judge Advocate.

(The following will be added to the record of the last case brought before the Court:)

There being no further business before it, the Court then, at —— o'clock — M., adjourned *sine die*.

——— ———,
Colonel —— *U. S. Artillery*,
President.

——— ———,
1st Lieut. —— *U. S. Artillery*,
Judge Advocate.

(A space of one page should be left at the close of each record, for the decisions and orders of the Reviewing Authority. The proceedings should be recorded on legal-cap paper, each record folded in four folds, and indorsed on the first fold as follows:)

—— BARRACKS,
——, ——,
——, 187 .

Proceedings of a General Court-Martial, convened by Special Orders No. —, dated Headquarters Department of the ——, ——, 187 .

Colonel I —— *V* ——,
—— *Artillery*,
President.

1st Lieut. A —— *B* —— *G* ——,
—— *Artillery*,
Judge Advocate.

CASE TRIED.
Private E —— F ——,
—— Artillery.

See *Courts-Martial*.

GENERAL DES GALERES.—A Commander of the Galleys, an officer of high rank and extensive jurisdiction in France.

GENERAL DES VIVRES.—A sort of Chief Commissary or Superintendent General of Stores, whose functions were to provide ammunition, bread, and biscuit for the French army.

GENERAL GUIDES.—In each Infantry Battalion of the United States army there are two general guides selected by the Colonel from the Sergeants most distinguished for carriage under arms and accuracy in marching. The general guides are posted in the line of file-closers, opposite the right and left flanks of the battalion; the one on the right of the battalion is designated *right general guide;* the other, *left general guide*.

GENERAL HOSPITALS.—Hospitals specially formed, on the outbreak of a war, for the reception of the sick and wounded who can no longer be kept in the field-hospital. They are of such importance in a campaign that the best position should be chosen for them, both as regards safety and for sanitary reasons. General hospitals should be within easy distance of the army by rail or water. In selecting buildings for such purposes, ventilation and drainage are of primary importance. Huts and tents are frequently used as general hospitals, and are always preferable to private houses, as the latter are often too small for the purpose required of them, and do not always afford the regulation cubic space of air. The size of general hospitals should be limited to the reception of 500 or 600 men at a time; and when it can be managed, they should be cleared out as quickly as possible, and the invalids sent home to be distributed among the military hospitals. Considering the vastness of the armies of the present day, the subject of hospital accommodation is a difficult question; the care of the sick and wounded must therefore, to some extent, be left to the many kind and liberal people who follow armies with the view of attending on the sick, and of distributing the many comforts they take with them, such as clothing, medical and other stores, that have been collected and forwarded, not only from the country of the sick and wounded, but from foreign nations. Such, it is happy to think, is the sympathetic and loving feeling evinced nowadays by the good and benevolent when war breaks out.

GENERALISSIMO.—The Chief Officer in command of an army. This word is used in most foreign countries, and was first employed to designate the absolute authority of Cardinal Richelieu when he went to command the French army in Italy.

GENERAL MAJOR.—A particular rank or appointment, whose functions correspond with those of a Ci-devant Marshal of France. This situation is intrusted to a General Officer, and is only known among the armies of Russia and some other Northern Powers. He takes precedence in the same manner that our Major Generals do of all Brigadier Generals and Colonels, and is subordinate to Lieutenant Generals. Frequently called *Général de Bataille*.

GENERAL OFFICER.—An officer of the General Staff of an army to whom is intrusted the command of a body of men not less in strength than a brigade. In an army of very large proportions the normal sequence of command would be the following: the General Commanding-in-Chief, the Generalissimo, or Field Marshal, would command the whole force; the Generals would have the separate *Corps d'Armée;* the Lieutenant Generals, wings of those *Corps d'Armée;* the Major Generals, divisions in the wings; and Brigadier Generals, brigades in the divisions. In practice, however, an army is rarely large enough to allow of this exact scheme of a military hierarchy being strictly carried out.

In the British service Colonels become Major Generals (except in cases of selection for very distinguished service) in order of seniority, provided each has served on full pay for a certain number of years; promotion to be Lieutenant Generals and Generals follows in exact order of seniority. From the last, promotion to the exceptional rank of Field Marshal is conferred in rare instances by the special favor of the Sovereign, who represents in person the sole command and possesses the patronage of the whole land forces. In addition to the Colonels who become effective Generals, officers who have retired on half-pay at earlier periods of their careers rise by seniority to the rank of General Officers; but they continue, notwithstanding, to receive only the half-pay of the rank in which they retired. With regard to remuneration, General Officers hold 164 honorary Colonelcies of regiments, worth, with few exceptions, £1000 each per annum, and the remainder receive *unattached* pay of £600 a year, if they have been in the Guards; £1 6*s*.3*d*. a day, if in the Artillery or Engineers; and £1 5*s*. a day, if previously in the Line. This pay is received during non-activity, but when employed actively a General receives, in addition, £5 13*s*. 9*d*. a day; a Lieutenant General, £3 15*s*. 10*d*.; and a Major General, £1 17*s*. 11*d*., besides various allowances. The only Generals' commands in the British service are, during peace, the command-in-chief of the army generally and of the forces in India, and sometimes in Ireland. In the estimates for 1876–77 there are 7 Lieutenant Generals, 18 Major Generals, and 5 Brigadier Generals employed actively, exclusive of the numbers serving in India. The last-named rank is only a temporary one in the English service, and conferred very commonly on the senior regimental officer of the corps composing the brigade: during duty as Brigadier he receives £1 8*s*. 6*d*. a day in addition to regimental or other pay. *Captain General* is a rank very rarely conferred by the Sovereign, who holds it *ex officio.* There has been no Captain General other than the Sovereign during the present century.

In the United States the word *General* is used with much license, both in military and civil affairs. Besides Brigadier and Major General we have a Lieutenant General, Commissary General, Quartermaster General, etc. In the militia of the several States there are officers with similar designations and duties. In law we find the Attorney General of the United States, and similar officers in most of the States. The head of the powerful Society of the Order of Jesus is known as the General. The French army has Generals of Division and Lieutenant Generals.

GENERAL OF THE ARMY.—A title given to the General in the United States army. The Revised Statutes provide that when a vacancy occurs in the office of General or Lieutenant General such office shall cease, and all enactments creating or regulating such offices shall, respectively, be held to be repealed. While the office existed, the military establishment was under the orders of the General of the Army in all that pertained to its discipline and military control, and all orders and instructions relating to military operations, or affecting the military control and discipline of the army, issued by the President or the Secretary of War, were promulgated through the General of the Army. With the retirement of General William T. Sherman in 1884, the office of General of the Army ceased, and at present the rank of Lieutenant General is the highest in the United States army. The General of the Army, while in office, was permitted to have a number of Aids, not exceeding six, who held, while serving on his Staff, the rank of Colonel of cavalry. See *General Officer*.

GENERAL ORDERS.—Orders issued to announce the time and place of issues and payments; hours for roll-calls and duties; the number and kind of orderlies, and the time when they shall be relieved; police regulations, and the prohibitions required by circumstances and localities; returns to be made, and their forms; laws and regulations for the army; promotions and appointments; eulogies or censures to corps or individuals, and generally whatever it may be important to publish to the whole command. See *Orders* and *Special Orders*.

GENERAL SERVICE.—In the United States army, the whole number of the general-service men of all grades and designations allowed as clerks for Division, Department, and District Headquarters, and for Superintendents of the Recruiting Service, is as follows: 14 Sergeants, 28 Corporals, 109 Privates, and 9 Topographical Assistants. The rates of commutation of rations, fuel, and quarters of the general-service clerks are fixed by the Secretary of War. The General of the Army determines from time to time the distribution that shall be made of the clerks, according to the exigencies of the service, among the several commands, and the above number must include all those on duty in the Adjutant General's, Quartermaster's, Subsistence, Medical, and all other Staff departments. The men of the general-service detachment are not employed on any other than clerical duties. If Hospital Stewards are employed for clerical duty in the offices of the Medical Directors, they must also be included in the total number allowed, and rated, so far as commutation is concerned only, as privates. In addition to the above number for *clerks*, the Commanding Generals of Military Divisions and Departments, the Commanding Officer, District of New Mexico, and the Superintendents of the Recruiting Service, may, if it be necessary, detail enlisted men from troops under their command as *messengers*, not to exceed five for each Division Department, two for the District named, and one to each Superintendent. Enlisted men so detailed as messengers receive the commutation and extra pay as follows:

Commutation.			Extra pay per day.
Rations per day.	Fuel per month.	Quarters per month.	
$0 50	$8 00	$10 00	$0 20

Whenever a headquarters is at a military post, fuel and quarters are furnished the clerks and messengers in kind, if practicable. When furnished in kind, commutation therefor also is not paid. The several Commanders may, at their discretion, discharge any of their general-service clerks and fill the vacancies in the authorized strength of the detachment by transfers from companies or enlistments in the general service. When, however, the service of any can be dispensed with, they are discharged or transferred to companies and their places not filled.

GENERAL-SERVICE WAGON.—A wagon of ordinary construction, having a long body covered with water-proof canvas; it is fitted for double draught, and has wheels and axletrees of great strength. It will carry 1½ tons, or take 20 powder-cases.

GENERALSHIP.—The office of General; the exercise of the functions of a General; the skill and conduct of a General Officer; military skill in any Commander.

GENEVA CONVENTION.—An agreement concluded at the International Conference which was held at

Geneva, 1864, under the presidency of General Dufour, the Swiss Plenipotentiary, for the purpose of ameliorating the condition of the sick and wounded in time of war. The credit of originating this Conference must be given to two citizens of Geneva, Dunant, a physician, who published a startling account of what he had witnessed in two military hospitals on the field of Solferino, and his friend Moynier, Chairman of the Society of Public Utility, who took up the idea of "neutralizing the sick-wagons," formed associations for its agitation, and at length pressed it upon the Governments of Europe, most of which sent representatives to the Conference. The Convention was drawn up and signed by them on the 22d of August, and since then it has received the adherence of every European Power, and one Asiatic (viz., Persia). The Convention consists of ten articles, of which the last two are formal. The others provide (1) for the neutrality of ambulances and military hospitals as long as they contain any sick; (2) for that of the Staff; (3) that the neutrality of these persons shall continue after occupation of their hospitals by the enemy, so that they may stay or depart, as they choose; (4) that if they depart, they can only take their private property with them except in case of ambulances, which they may remove entire; (5) that a sick soldier in a house shall be counted a protection to it, and entitle its occupants to exemption from the quartering of troops and from part of the war requisitions; (6) that wounded men shall, when cured, be sent back to their own country on condition of not bearing arms during the rest of the war; (7) that hospitals and ambulances shall carry, in addition to the flag of their nation, a distinctive and uniform flag bearing a red cross on a white ground, and that their Staff shall wear an arm-badge of the same colors; (8) that the details shall be left to the Commanders. A second Conference was held at Geneva on the same subject in 1868, and a supplementary Convention drawn out, which, though not formally signed, has been acquiesced in by all the signatories of the original Convention, except the Pope, and which, while still unratified, was adopted provisionally by France and Germany in the War of 1870. It consists partly of the interpretations of the former Convention, and partly of an application of its principles to maritime wars. Its main provisions are these: That when a person engaged in an ambulance or hospital occupied by the enemy desires to depart, the Commander-in-Chief shall fix the time for his departure, and, when he desires to remain, that he be paid his full salary; that account shall be taken in exacting war requisitions not only of the actual lodging of wounded men, but of any display of charity towards them; that the rule which permits cured soldiers to return home on condition of not serving again shall not apply to officers, for their knowledge might be useful; that hospital-ships, merchantmen having wounded on board, and boats picking up wounded and wrecked men shall be neutral; that they shall carry the red-cross flag, and their men the red-cross armlet; the hospital-ships belonging to Government shall be painted white with a green strake, those of Aid Societies white with a red strake; that in naval wars, any strong presumption that the Convention is being abused by one of the belligerents shall give the other the right of suspending it towards that Power till the contrary is proved, and, if the presumption becomes a certainty, of suspending it to the end of the war.

GENIUS.—This word, which conveys the most lofty eulogium that can be applied to intellectual excellence, meant originally the tutelary god or demon that was anciently supposed to preside over the birth and destinies of every individual human being. The peculiarities attending the character and career of each person came thus to be attributed to the higher or lower nature of their attendant genii. Thus arose one of the meanings now attached to the word—namely, the special bent, aptitude, or faculty which any one possesses; as a genius for generalship, etc. In a military sense the term implies a natural talent or disposition to every kind of warlike employment, more than any other.

GENOUILLERE.—In fortification, a term for that part of the parapet of a battery which lies under the embrasure. The name is derived from French *genou*, knee, as representing the ordinary height of the genouillère above the platform on which the gun is worked. The height of the genouillère is regulated by that of the gun-carriage, generally from 2 to 3 feet.

GENOUILLIERES.—Small plates of iron, of various shapes, fixed by straps and buckles over the mail, in order to give an increased security to the joints at the knees. See *Armor*.

GENS.—This Latin word, to which so many important political and social meanings came to be attached, signifies, properly, a race or lineage. From it our own words—gentleman, gentility, etc., have come to us through the French *gentilhomme*, the primary meaning of which was, one who belonged to a known and recognized stock. By the Romans it was sometimes used to designate a whole community, the members of which were not necessarily connected by any known ties of blood, though some such connection was probably always taken for granted. In this sense we hear of the *Gens Latinorum, Campanorum*, etc. But it had a far more definite meaning than this in the Constitutional Law of Rome. According to Scævola, the Pontifex, those alone belonged to the same *gens*, or were "gentiles," who satisfied the four following conditions, viz.: 1. Who bore the same name; 2. Who were born of freemen; 3. Who had no slave amongst their ancestors; and 4. Who had suffered no *capitis diminutio* (reduction from a superior to an inferior condition), of which there were three degrees, maxima, media, minima. The first (maxima capitis diminutio) consisted in the reduction of a free man to the condition of a slave, and was undergone by those who refused or neglected to be registered at the census, who had been condemned to ignominious punishments, who refused to perform military service, or who had been taken prisoners by the enemy, though those of the last class, on recovering their liberty, could be reinstated in their rights of citizenship. The second degree (media capitis diminutio) consisted in the reduction of a citizen to the condition of an alien (*Latinus* or *peregrinus*), and involved, in the case of a *Latinus*, the loss of the right of legal marriage (*connubium*), but not of acquiring property (*commercium*); and in the case of the *peregrinus*, the loss of both. The third degree (minima capitis diminutio) consisted in the change of condition of a *paterfamilias* into that of a *filius familias*, either by adoption (*adrogatio*) or by legitimation. In the identity of name, some sort of approach to a common origin seems to be here implied. The gens thus consisted of many families, but all these families were supposed to be more or less nearly allied by blood—to be, as we should say, kindred. A Roman gens was thus something very nearly identical with a Celtic clan, the identity or similarity of name being always supposed to have arisen from relationship, and not from similarity of occupation, as in the case of the Smiths, Taylors, Lorimers, etc., of modern Europe. There was this peculiarity, however, about the gens which did not belong to the clan—viz., that it was possible for an individual born in it to cease to belong to it by *capitis diminutio*, or by adoption, or adrogation as it was called when the person adopted was *sui juris*. If the adoption was by a family of the same gens, the gentile name, of course, remained unchanged. In the case of a person dying intestate, his gentiles, failing nearer relatives, were his heirs, and they undertook the duties of guardianship in the like circumstances. The gens was further bound together by certain sacred rites, which were imposed on the whole of its members, and for the celebration of which it probably possessed, in common property, a *sacellum* or sacred spot, inclosed and containing an altar and the statue of the god to whom it was dedicated. According to the traditional accounts of the old Roman Constitution, the Gentes were a subdivision of the Curiæ, as the Curiæ were subdivisions of the Tribe. In this view of the matter, the original idea of the gens becomes simply that of the smallest political division, without any relation to kindred or other ties.—An excellent article on the gens by Mr. George Long, in which references to the principal German authorities on the subject are given, will be found in Smith's *Dictionary of Roman Antiquities*.

GENTILHOMMES DE LA GARDE.—A company commonly called *Au bec de Corbin*, from the battle-axe which they carried. The company went through many alterations during the Monarchy of France. During the last years of that government it consisted of 200 guards, under the command of a Captain, a Lieutenant, and an Ensign. The Captain had the power of giving away the subaltern commissions, and had, moreover, the entire management of the rest; every vacancy being in his gift. When the company was first raised its particular duty was to attend the King's person, and to be constantly near him on the day of battle.

GENTLEMEN-AT-ARMS.—The body-guard of the British Sovereign, and, with the exception of the Yeomen of the Guard, the oldest corps in the British service. It was instituted in 1509 by Henry VIII., and now consists of 1 Captain, who receives £1200 a year; 1 Lieutenant, £500; 1 Standard-bearer, £310; 1 Clerk of the Check, £120; and 40 Gentlemen, each with £70 a year. The pay is issued from the Privy Purse. Until 1861, the commissions were purchasable, as in other regiments; but by a royal command of that year purchase has been abolished in the corps, and henceforth the commissions as Gentlemen-at-Arms are to be given only to military officers of service and distinction. The attendance of the Gentlemen-at-Arms is now rarely required, except on the occasions of drawing-rooms, levées, coronations, and similar important state ceremonies. The appointment, which is in the sole gift of the Crown, on the recommendation of the Commander-in-Chief, can be held in conjunction with half-pay or retired full-pay, but not simultaneously with any appointment which might involve absence at the time of the officer's services being required by the Sovereign.

GEOGRAPHICAL DEPARTMENTS AND DIVISIONS.—In the United States, a Geographical Military Division consists of a number of Geographical Military Departments, and is usually under the command of a General Officer. Military Geographical Divisions and Departments are established and their Commanders are assigned by orders from the War Department. In time of peace, Army Corps, Divisions, or Brigades are not formed. Officers commanding Military Divisions and Departments exercise supervision and command over all the military forces of the United States within their territorial limits, whether of the Line or Staff, where special exception is not made by the War Department Subject to the approval of the General of the Army, a Division Commander regulates the establishment of military districts and posts, and originates, directs, or approves military operations within his Departments. In case of emergency, he transfers troops from one of his Departments to another requiring reinforcements. Division and Department Commanders are expected to decide all matters properly coming within their jurisdiction, or to make appropriate remarks upon such papers as they forward for decision of higher authority. A Division Commander decides cases sent him by way of appeal. Department Commanders exercise a general supervision of all military reservations within the limits of their commands, and will use force to remove squatters or trespassers when, in their judgment, it becomes necessary. See *Department Commander*, *Division Commander*, and *Military Department*.

GEOMETRICAL PROGRESSION.—A series of quantities are said to be in geometrical progression when each term of the series is equal to that which precedes it multiplied by some constant factor—i.e., some factor which is the same for all the terms; or, in other words, when the ratio of any two successive terms is the same. Thus a, ar, ar^2, ar^3. . . and 2, 6, 18, 54 . . . are geometrical series. The sum of n terms of the former series may be easily obtained. Let it be S. Then $S = a + ar + ar^2 + \ldots + ar^{n-1}$. Multiply both sides by r, we have $rS = ar + ar^2 + \ldots + ar^n$. Subtracting the former of these expressions from the latter, we have $(r - 1)S = ar^n - a$. Whence we have $S = a \cdot \frac{r^n - 1}{r - 1}$. If the series be one whose terms constantly diminish, i.e., if $r < 1$, and then if we suppose n indefinitely great, r^n will be indefinitely small, and we shall have $S = \frac{a}{1 - r}$ for the sum of the series extended *ad infinitum*. For example, the sum of the series $\frac{3}{10} + \frac{3}{10^2} + \frac{3}{10^3} + \ldots$ *ad infinitum* is $\frac{1}{3}$. It is obvious that any three of the four quantities a, r, n, S being given, the equation $S = a \cdot \frac{r^n - 1}{r - 1}$ will enable us to find the fourth. Series of this class are frequently encountered in the solutions of problems in gunnery.

GEOMETRIC CHUCK.—A chuck having a radial slider to which the work is attached, the said slider oscillating in a plane at right angles to the axis of motion, so as to produce curved lines in various patterns, as regulated by special devices. See *Chuck*.

GEOMETRY.—A science discussing and investigating the properties of definite portions of space under the fourfold division of lines, angles, surfaces, and volumes, without regard to any physical properties which they may have. It has various divisions, e.g., plane and solid geometry, analytical or algebraical geometry, descriptive geometry, and the higher geometry. Plane and solid geometry are occupied with the consideration of right lines and plane surfaces, and with the solids generated by them, as well as with the properties of the circle, and, it may be said, the sphere; while the higher geometry considers the conic sections and curved lines generally, and the bodies generated by them. In the higher geometry, immense advances have recently been made through improved methods, the application of modern analysis, and the various calculi in algebraical geometry, the nature of which is explained in the article Co-ordinates. Descriptive geometry, a division of the science, so named by Monge, is properly an extension or general application of the principle of projections, its object being to represent on two plane surfaces the elements and character of any solid figure. It has many practical applications. When one surface penetrates another, for instance, there often result from their intersection curves of double curvature, the description of which is necessary in some of the arts, as in groined vault-work, and in cutting arch-stones, etc., and this is supplied by descriptive geometry. On geometry likewise depends the theory of gunnery, mining, mechanics, hydraulics, pneumatics, etc.

GEOPHAGISM.—The custom of dirt-eating, indulged in by the lowest order of savages, but most particularly in Terra del Fuego. A kind of ferruginous clay is regularly sold for food in certain parts of Bolivia. The practice is usual among the negroes of the West Indies, and to some extent among North American Indians, while Laplanders mix clay with the flour of which they make their bread.

GEORGE.—1. The badge of the Order of the Garter, exhibiting the figure of St. George on horseback piercing the fallen dragon, which lies on a mount.

2. The banner of St. George—white with a red cross. According to Sir N. H. Nicolas, the cross of St. George was worn as a badge over the armor by every English soldier "in the fourteenth and subsequent

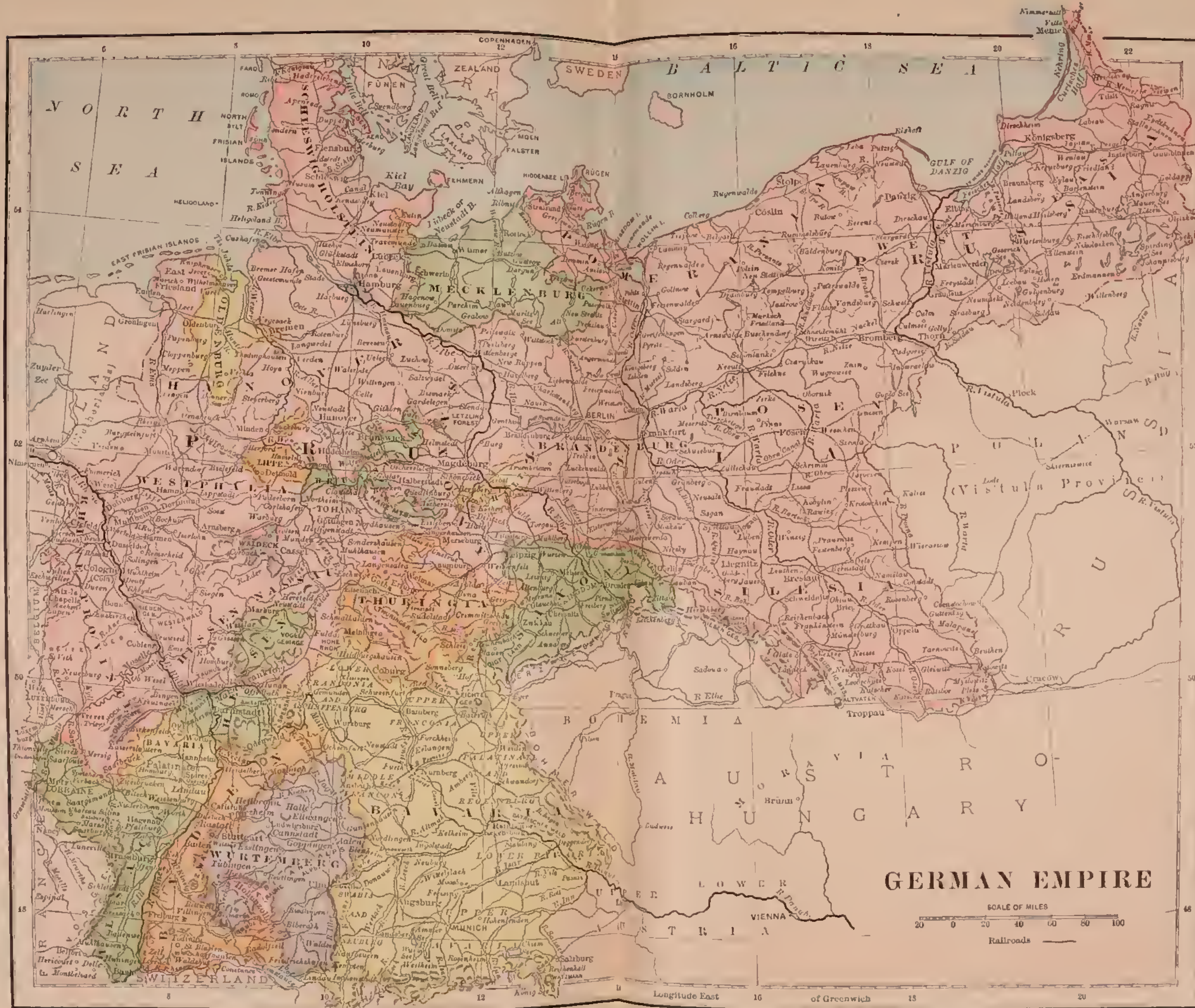
centuries, although the custom did not prevail at a much earlier period," to indicate that he was in the service of the Crown. On the invasion of Scotland by Richard II. in 1386 it was ordained that "everi man of what estate, condicion, or nation they be of, so that he be of oure partie, bere a signe of the armes of Saint George, large bothe before and behynde, upon parell that yf he be slayne or wounded to deth, he that hath so doon to hym shall not be putte to deth for defaulte of the crosse that he lacketh. And that non enemy do bere the same token or crosse of St. George, notwithstandyng if he be prisoner, upon payne of deth." A similar ordinance was adopted by Henry V. for the government of his army in France.

3. St. George, patron of England and Russia. His origin is extremely obscure, and the very oldest accounts of him which are extant contain a strange admixture of history and legend. He is honored both in the East and the West as a martyr, and the Greek acts of his martyrdom fix the date of his death as the persecution under Diocletian; but these acts are, by the confession even of Roman Catholic hagiologists, undoubtedly spurious. On the other hand, it is asserted that the canonization of George is one of the many errors which Protestant historians freely impute to the Roman calendar, and that the George who is thus reputed a saint and martyr is no other than the turbulent and unscrupulous Arian partisan, George of Cappadocia, whom his Arian followers revered as a saint, and imposed as such upon the credulity of their Catholic countrymen. It must be confessed, however, that the best modern authorities, Catholic and Protestant, agree in admitting the great improbability of this allegation. Heylin is of one mind in this matter with the Jesuit Papebroch, and Dean Milman adopts the arguments and agrees in the opinion of the Roman Catholic Bishop Milner. The truth is, that whatever is to be said of the early accounts of the martyrdom of George, the fact of his being honored as a martyr by the Catholic Church, of churches being dedicated to him, and of the Hellespont being called "St. George's Arm," is traced by Papebroch, by Milner, and by other writers to so early a date, and brought so immediately into contact with the times of the angry conflicts in which George of Cappadocia figured as an Arian leader, that it would be just as reasonable to believe that the Catholics of England at the present day would accept Lord George Gordon as a Catholic Saint, as to suppose that the Catholics of the East—while the tomb of Athanasius was hardly closed upon his honored relics—would accept as a sainted martyr his cruel and unscrupulous persecutor. Indeed, it cannot be doubted that the St. George of the Eastern Church is a real personage, and of an earlier date than George of Cappadocia—very probably of the date to which these acts, though otherwise false, assign him. The legend of his conflict with the dragon arose most probably out of a symbolical or allegorical representation of his contest with the pagan persecutor. As in this ancient legend St. George appears as a soldier, he was early regarded as one of the patrons of the military profession. Under this title he was honored in France as early as the sixth century; but it was not until after the Crusaders, who ascribed their success at the siege of Antioch to his intercession, returned to Europe from the Holy War, that the religious honor paid to him reached its full development. He was selected as the Patron Saint of the Republic of Genoa, and also of England. At the Council of Oxford in 1222 his feast was ordered to be kept as a National Festival. In 1330 he was made the Patron of the Order of the Garter by Edward III.; and even since the Reformation the ancient sentiment is still quite popularly maintained.

GERBE.—An ornamental fire-work, in the shape of a strong paper tube filled with a burning composition. The ends are tamped with moist plaster of Paris or clay. See *Pyrotechny*.

GERIT.—The French name of a Turkish dart about two and one half feet long. It was formerly in very common use.

GERMAN ARMY.—One of the largest Continental armies of Europe. By the Treaty of Prague, concluded between Austria and Prussia after the war of 1866, a new German Confederation was formed. A few months later Prussia concluded Conventions with States forming the new Confederation, by which they were bound to adopt any quarrel of Prussia arising out of the recent events, and to place their military strength at the absolute disposal of the Prussians. In order to insure a unity of organization, the military system of the latter was adopted by these States. And now, by the Constitution of the German Empire, bearing date the 16th of April, 1871, the land forces of all the States form a united army under the command of the Emperor. The German army thus includes the Contingents of Prussia (with Hanover), Bavaria, Saxony, Wurtemberg, Baden, and a number of other States. The military system of the German Empire is as follows, and it will be remarked how closely the French system resembles it. Every man is liable to military service, and must render such service personally, neither substitutes nor purchase of exemption being allowed. There are, however, certain social exemptions made, such as for sons of widows, supports of families, etc. The number of recruits annually raised is about 143,000 men, and the peace strength of the army is fixed at 401,659 men (one-year volunteers not included), or about 1 per cent of the population. The age of conscription is 21; the period of military service is 12 years, divided into three portions of 3, 4, and 5 years; 3 years are passed by the Conscript in a Regular Regiment, the next 4 years (on furlough) in the Reserve, and the final period of 5 years in the *Landwehr* or Second Reserve of his district. This brings the soldier to about 32 years of age. After this he is incorporated in the *Landsturm*, or service for home defense in case of war. Every young man can be called up 3 years in succession; those who are exempted in their third year are passed into the *Ersatz-Reserve*, and are free from military service, but can be called upon in time of war. In order that civil professions may not be affected by military exigencies, youths of good character and education, and who have taken university or college degrees, can qualify themselves for one year's service. These *Einjährigen Freiwilligen* (one-year volunteers) have to provide themselves with everything, viz., their accouterments, equipment, and horse, if in the cavalry. The regiments of the regular army during peace-time are, on the breaking-out of war, raised to double their number by recalling an equal number of men from the Reserve, and each reserve-man so recalled returns not merely to the same battalion, but even to the very company in which he had passed the first years of his military life. The *Landwehr* battalion is the basis of the local organization, both for recruiting and mobilization. In peace-time these battalions exist only in cadres. By this system Germany can easily place in the field an army of 1,350,000 men, not including the *Landsturm*, and has now a peace-establishment of about 428,000 voted for 7 years, including officers and volunteers, with a budget of £16,000,000. The German army is organized on the territorial system, and divided into 18 army corps, of which 13 are furnished by Prussia, including the Contingents furnished by Hanover, Schleswig-Holstein, and the minor States annexed to Prussia in 1866; 2 by Bavaria, 1 by Saxony, 1 by Wurtemberg, and 1 by Baden, and the Contingent by Alsace-Lorraine. Each *Corps d'Armée* has a district, which is formed by the Province within which it is raised, recruited, and stationed. These corps districts are subdivided into divisions and brigades, and these again into *Landwehr* battalion districts. Districts are further subdivided into company districts, of which there are from 3 to 6 to a battalion. The *Corps d'Armée* of the Guard and one furnished


GERMAN EMPIRE
SCALE OF MILES
20 0 20 40 60 80 100
Railroads
Longitude East of Greenwich
NORTH SEA
BALTIC SEA
SWEDEN
ZEALAND
FÜNEN
BORNHOLM
RÜGEN
GULF OF DANZIG
MECKLENBURG
BRANDENBURG
HANOVER
WESTPHALIA
THURINGIA
BAVARIA
WURTEMBERG
SWITZERLAND
BOHEMIA
AUSTRO-HUNGARY
LOWER AUSTRIA
MORAVIA
VIENNA
Brünn
Troppau
Cracow
Plock
Warsaw
Kalisz
Königsberg
Tilsit
Memel
Danzig
Stolp
Cöslin
Thorn
Bromberg
Posen
Breslau
Liegnitz
Oppeln
Berlin
Frankfurt
Stettin
Hamburg
Bremen
Lübeck
Kiel
Flensburg
Schwerin
Hanover
Brunswick
Magdeburg
Halle
Leipzig
Dresden
Cassel
Cologne
Coblenz
Mannheim
Stuttgart
Munich
Nurnberg
Augsburg
Salzburg
Strassburg
Metz
Freiburg
Constance
Coburg
Würzburg
Prague
Sadowa

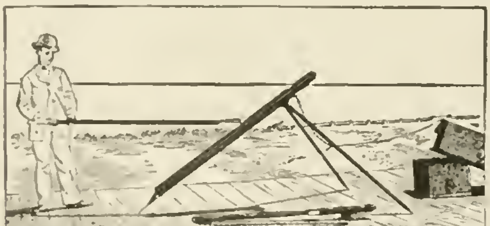
by Saxony consist of 2 infantry divisions and 1 of cavalry. The others have 2 divisions, except the 11th, which has 3. Each division has 2 infantry brigades and 1 of cavalry. The Saxon and the 12th corps have 2 brigades of infantry; the cavalry of the Guard has 3, the Saxon and the 15th corps 2 brigades of cavalry each. Independently of these divisions, each corps possesses 1 or 2 battalions of Rifles (the Guards 1 of Rifles and 1 of Sharp-shooters, and the Bavarian army 10 battalions of Rifles), 1 regiment of Field-artillery, 1 regiment or battalion of Foot-artillery, 1 battalion of Pioneers, and 1 of Military Train, as well as 1 battalion *Etappen* troops, 1 of Instruction, 1 of *Gendarmerie*, belonging to the Staff or permanent army. There are 74 brigades of infantry; each brigade is composed of 2 regiments of the Line and 2 of the *Landwehr*, giving a total of 148 regiments of the line. A regiment on war-footing has 60 officers, 3000 men, 73 non-combatants, with 105 horses and 19 wagons. The regiments of infantry consist of 3 battalions, the third one being Fusiliers. Each battalion has 4 companies, and has a peace-strength of 552 of all ranks, and a war-strength of 1022. Besides these field-battalions, a fourth or depot battalion, 1240 strong, is formed on mobilization. The Rifles and Sharp-shooters (*Jäger* and *Schützen*) are not organized in regiments, but form independent battalions. They are recruited from picked men, chosen throughout the army corps district. The cavalry of the German army is divided into 38 brigades; 1 brigade is composed of 4 regiments, 15 of 3, and the 22 others of 2 regiments, giving a total of 93 regiments—12 of Cuirassiers (including those of the Guard), 34 of Dragoons, 18 of Hussars, 25 of Lancers, and 4 Saxon regiments. In peace-time these regiments consist of 5 squadrons, of 4 officers and 135 men each; in war-time they take the field with 4 squadrons of 150 each, while a fifth remains behind to form the depot. The brigades of field-artillery are generally composed each of 2 regiments, of which 1 is composed of 2 sections of 4 batteries, forming the division artillery; and the other, consisting of 2 sections of 3 batteries, and 1 section of horse-artillery of 3 batteries, forming the artillery of the *Corps d'Armée*. Each battery has 4 guns. The Foot-artillery brigade is, with few exceptions, composed of 2 battalions of 4 companies each; to these must be added 1 company of Instructors for the School of Gunnery, and 1 company for laboratory purposes. The battalions of Pioneers have each 4 companies—1 of pontons, 2 of sappers, and 1 of miners. The *Etappen* battalion, which is under the direct command of the Chief of the Staff, has also 4 companies. The peace-establishment of each company is 146 men, but on the war-footing it is increased to 218 men. Further, there are 1 Railway battalion and 13 sections of Field-telegraph. The Train is a mere skeleton on a peace-footing, and has 37 companies with a strength of 5049, which amounts to nearly 49,000 men when it takes the field. The German artillery is armed with guns of cast-steel (Krupp's system); the field-batteries have 8.8-cm. guns, and throw shrapnel weighing 17.9 lbs.; the horse-artillery have 7.85-cm. guns, throwing the same nature of shell, weighing 12.2 lbs. On war being declared, the different *Corps d'Armée* are formed into armies; and to obtain the necessary strength to place them on a war-footing, the Government calls under the Colors the yearly Contingent of Conscripts, the Reserves, and the men of the *Landwehr*. The whole army is then divided into (1) field, (2) depot, and (3) garrison troops. The field-troops of a *Corps d'Armée* comprise—(*a*) Two divisions of infantry, each having 1 regiment of cavalry and 1 detachment of artillery (24 guns). (*b*) The artillery of the *Corps d'Armée*, of 1 regiment of field-artillery, of 6 field-batteries, and 2 horse-artillery batteries. (*c*) Three independent companies of Pioneers. (*d*) *Sections of columns*, viz.: 10 columns of ammunition, 3 of pontons and train, 5 of provisions, 3 sanitary detachments, 1 remount depot, 1 column of field-batteries, 5 columns of land-transport, and 12 ambulances, the *intendance* (commissariat), field-post, etc. The other cavalry regiments, not attached to the different divisions, are formed into cavalry divisions of 2 and 3 brigades, and 3 batteries of horse-artillery. These divisions are under the immediate command of the General-in-Chief. The army is commanded by the Emperor, with a War Minister, and a Chief of the Staff under him. The War Department is divided into three principal offices, as follows: 1. Central office, including the Ministerial one. 2. General War Department, comprising organization, mobilization, quartering, training; strategical and purely military questions. 3. Military Finance Department: pay, clothing, equipment, and supply. The great General Staff of the German army is thus divided: 1. Central Bureau: general correspondence and direction of all the other sections. 2. Three sections; collect all available and latest information concerning European armies, etc., each section having a certain number of countries under its charge. 3. Railway section. 4. Military history section: historical records, histories of great wars, annals, etc. 5. Geographical statistical section, connected with the topographical section: topography and statistics of foreign nations; statistics of Germany. 5. Topographical and land triangulation: survey (land and cadastral), with special regard to military requirements. 7. Intelligence-office. 8. Map-room: store-room for original surveys, maps for distribution. There are 61 officers on the General Staff at Berlin, and they are divided into two classes: 1. Active Staff, liable to serve with corps and divisions in their turn; and 2. The *Neben-Etat*, or accessory establishment, consisting of from 30 to 40 officers noted for special acquirements, but who do not belong to the first division. There are besides 113 employés, such as registrars, draughtsmen, etc. Bavaria and other German States have similar establishments, under the supervision of the Great General Staff at Berlin. The mode of officering the German army is in two ways: 1. By candidates passing the required examination in general subjects, serving a short time in the ranks or otherwise as non-commissioned officers, and qualifying in the theoretical knowledge of their profession after a nine months' course of study at the *Kriegsschule*, or School of War. 2. By passing the latter examination direct from a special superior class of the Corps of Cadets. There is no examination for promotion to any commissioned rank in the army, promotion being obtained by relative merit. Men of ability are noticed by those in authority and promoted; those of inferior capacity do not progress. See *Army*.

GERMAN LIFE-SAVING ROCKET.—The 5-centimeter German life-saving rocket (5^{cm} Rettungsrakete) is composed essentially of a body, head, base, rocket-stick, and chain. The rocket-case or body is cylindrical, made of sheet-metal .05 inch in thickness. The head is ogival, with a shoulder that extends one fourth of an inch beyond the case, and has a cylindrical tenon to fit the front end of the rocket-case. The latter is secured to the head by screws. The inside of the rear end of the case is reinforced for 1.1 inch of its length by a cylindrical metallic ring, which serves as a seat for the screws that attach the base to the body. The base extends to the rear, forming three ribs, placed triangularly, with all the metal removed from the axial portion to facilitate the escape of gas. These ribs conjoin at their posterior ends. An axial hole is drilled through this portion, having a female-screw thread cut upon its interior surface to receive the screw on the end of the rocket-stick. When prepared and packed for service the composition is covered by a water-proof cap, from which projects a fuse, extending 2.5 inches towards the rear. The fuse is steadied in its position by a strap of laboratory-paper reaching to one of the ribs. The fuse and cap are covered with a coat of shellac varnish. Care must be taken in handling not to break off the fuse, which is more or less exposed. The rocket-stick is of wood, enveloped at the front end by a metallic frustum of a cone, whose larger base receives the end of the stick, and whose smaller base is penetrated by the shank of a screw, intended to enter in the hole in the base of the rocket. The stick, frustum, and screw-shank are bound together, and held in place by two wrought-iron bolts of small diameter. The rear end of the rocket-stick is armed with an iron loop, with flattened arms, slightly curved to fit the outside of the stick. This loop serves as the point of connection for the rocket-chain. The diameter of the rocket-stick is slightly greater in the middle than at either end. All the metallic parts of this line-carrying projectile are painted black.

The following are the principal dimensions and weights:

	Inches.	Centimeters.
Total length of 5cm life-saving rocket....	23.5	59.69
Case or body:		
Length........	15.0	38.10
Exterior diameter.....................	2.15	5.45
Interior diameter.....................	2.05	5.20
Head:		
Total length..........................	5.2	13.20
Point—		
Length of	3.6	91.44
Diameter of base...................	2.65	6.73
Base-ring:		
Length...............................	1.1	2.79
Exterior diameter.....................	2.05	5.20
Interior diameter.....................	1.65	4 19
Base:		
Total length..........................	5.8	14.73
Diameter, front end...................	2.65	6.73
Diameter, rear end....................	1.25	3.17
Length, embracing case.	0.9	2.28
Length of female screw in rear end....	1.2	3.05
Width of ribs.........................	0.35	0.89
Rocket-stick:		
Total length........	39.4	100.07
Diameter at junction with rocket......	1.2	3.05
Diameter at larger base of frustum..	2.2	5.58
Rocket-chain:		
Total length..........................	87.0	220.98
Ring—		
Exterior diameter..................	1.5	3.81
Interior diameter..................	0.7	1.78
Links—		
Length...................	1.5	3.81
Width	0.75	1.90
Thickness.............	0.20	0.51
Total length of rocket and stick..........	61.7	156.71
	Pounds.	Kilos.
Weight of rocket........................	10.0	4.53
Weight of rocket-stick and chain........	5.5	2.49
Total weight of rocket complete.........	15.5	7.02

The Germans also use a large 8cm life-saving rocket. The form and construction of this rocket is essentially the same as the 5cm rocket, from which it differs only in dimensions and weight. The description of the 5cm rocket will answer for this one.



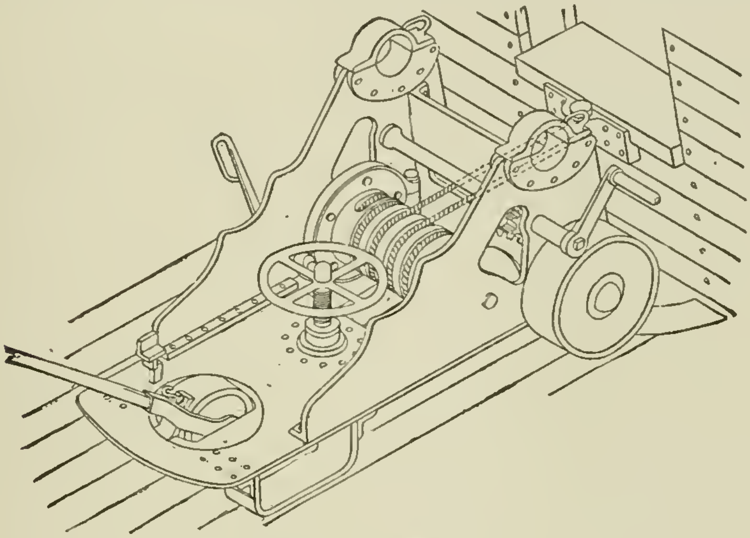
German 8cm Life-saving Rocket.

The German rocket-stand is trough-like in shape, and is supported by two legs near the front end and a curved iron foot or tang at the rear end. The trough like body of the tube is made of sheet-iron or steel, and is constructed from a single piece of metal, curved over a former of the required shape. A longitudinal slot in the bottom, 10.9 inches long and 1 inch wide, extends from the front end to the first exterior rib. This slot is for the reception of the rocket-chain, which is led along the bottom of the trough under the rocket and stick, and allowed to pass downward through this slot. The longitudinal edges of the trough are stiffened and strengthened by angle-pieces of iron running the whole length. These angle-pieces have one side riveted to the inside of the trough, forming the bearing surfaces for the rockets, and the other forming an exterior projecting flange. A rolled bar of iron, 1 inch wide and .3 inch thick, runs from the rear end of the longitudinal slot the whole length of the trough on the under side. The lower or rear end of this metallic bar projects about 10 inches beyond the frame, is decurved and pointed, to form the claw or tang for the support of this end of the trough. This is made of wood, shod at one end with a sharp-pointed steel socket, and armed at the other with a hollow brass tube, bent and split to form a hinged clamp. The latter is actuated by a lever and a spring. This staff is used to hold the *pillenlichte* for igniting the rocket-fuse. The sharp-pointed socket is for convenience in thrusting it into the ground in an upright position. If carelessly thrown aside, it is liable to be lost in the sand. The staff is painted the same color as the rocket-stand. The rocket line is made of hemp. The line is twisted, and is made with three strands, each composed of four yarns. The diameter of this line is .31 inch, or a little greater than "No. 9 Silver Lake braided cord." The rocket-line is stowed in the faking-box in the usual manner. The combined weight of the faking-box and line is 100 pounds, or 9.5 pounds greater than the United States service-box A, with a No. 9 linen line.

The following is the method of using the German rocket apparatus:

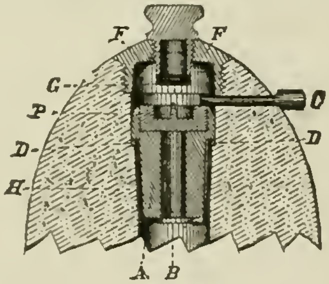
The apparatus is supposed to be at the firing-point. First remove the rocket-stand from its box, spread the legs, and place the stand with the axis of the trough pointing in the desired direction. Then give the proper elevation by raising or lowering the front end by means of the legs. A quadrant or combination-level is used to adjust the elevation. Place the faking-box several feet in front of the stand, turn it upside down, remove the frame and pins and false bottom. Incline the box to the front with its length in the direction of the line of fire, and place the false bottom or frame transversely on edge beneath the rear end of the box, to preserve the proper inclination towards the front. Then screw a rocket-stick into the base of one of the rockets, put the chain in the slot at the front end of the trough of the stand, and lead it along the bottom of the trough. Place the rocket in the trough over the chain, drawing the latter taut, and allow the end of the stick to abut against the plate at the lower end of the trough; carry the other end of the rocket-chain to the front and tie the rocket-line to the ring. The rocket is now ready to be fired. Take a *pillenlichte* and put the square end in the clamp of the firing-staff, which brings the end with the fulminating primer to the front. Next place the bell-shaped mouth of the firing-lock, with the firing-pin withdrawn, over the outer end of the *pillenlichte;* press the thumb upon the rear end of the firing-lever. This action relieves the firing-pin, the spiral spring throws it to the front, exploding the primer, which sets the composition on fire. Approach the rocket-stand, extend the firing-staff until the burning *pillenlichte* comes in contact with and ignites the fuse in the base of the rocket. After seeing that the fuse is properly ignited, stand clear of the apparatus. As soon as the fuse burns up to the base of the rocket, the composition takes fire, and the rocket, guided by the inclined trough of the stand, is launched to the front, carrying with it the stick, chain, and rocket-line. The object of the stick is to give steadiness to the flight, that of the chain to preserve the line from being burned off by the flames issuing from the rocket. See *Anchor-rocket, Life-saving Rockets, Pillenlichte,* and *Rockets.*

GERMAN NAVAL CARRIAGE.—Carriages of this kind have been recently constructed for light guns and introduced into the German naval service. They belong to the class of truck-carriages, are light, easily moved into battery, take up but little space, and are provided with a circular friction-brake, by which the recoil of the gun may be controlled at pleasure. A 6-inch gun mounted on one of these carriages was fired a number of times at Krupp's proof-grounds for test. The carriage worked well, checking the recoil within a short distance. As the principle on which the recoil is controlled may be as well used in the construction of some of the carriages for the land-service, it may not be out of place to give a short description of its leading peculiarities. The cheeks are made of thick iron plates, each cheek of a single piece, reinforced around the trunnion-holes by a semicircular plate of iron on each side of the cheek-plate, the two riveted together through the latter. The cheeks are joined together by a front and rear bottom transom and a front vertical transom of thick iron plate. The carriage is supported on two front and one rear truck-wheels, the latter being on an eccentric axle, thrown in or out of gear by the handspike projecting to the rear. When the rear wheel is not bearing, the rear end of the carriage rests on wooden bolsters, made fast to the under side of the rear bottom transom. When the carriage is in battery, two bolsters under the front ends of the cheeks rest on a traverse-circle raised slightly above the level of the platform. The shock of the discharge is thereby thrown on these bolsters, and not on the wheels and axle. In rear of the front truck-wheels there are two shafts running across the carriage, and having journal-boxes in the cheeks; the first one carries a pinion inside of the right cheek-plate and has a crank on each end, outside of the cheek; the other carries a windlass, with a cog wheel on one end and an iron drum on the other, just inside of the cheeks. The teeth of the wheel engage in those of the pinion. The drum is enveloped by a band-brake, which can be tightened by means of a screw, or within narrow limits by a lever placed on the outside of the left cheek, and held in any desired position by a pin through the lever and cheek-plate. A strong rope is made fast at its middle to the side of the vessel, or the parapet in front of the gun, and the two ends are wound around the windlass and made fast to it. A certain pressure is applied to the brake by means of the screw and lever for that purpose. When the gun is fired, the recoil of the carriage is overcome by the rope, the friction between the brake and the drum offering a certain resistance to the turning of the windlass and the unwinding of the rope. Carriages of this pattern are made in Dantzic, for the Prussian navy, by Mr. Wagenknecht, who also designed it. See *Sea-coast and Garrison Carriages*.



German Naval Carriage.

GERMAN PERCUSSION-FUSE.—In this fuse a metal plunger, A, having a central fire-hole, B, is let into the fuse-hole and rests against the shoulders, DD. Let into the top of the plunger and across its center is a metal bar, P, having a projecting point on its top side, the point being in center of fire-hole. The plunger is retained in its place by a pin, C, which passes transversely into the fuse-hole, the side of which is put in contact with the point of the cap. The outer end of the pin projects on the side of the shell, the projection being limited by the line of the cylindrical portion. The fuse-hole is closed by a screw-cap, F, having a small central screw-hole into which the fulminate cap, G, is screwed. When fired from a rifle-piece, the centrifugal force generated by the revolution of the shell throws out the pin, C; the plunger by its inertia is retained at the bottom of the chamber during the flight of the projectile; at the moment of impact the projecting point on the plunger impinges against the fulminate, which, exploding, ignites the charge in the shell.



The fulminate-cap, G, and pin, C, are not applied to the shell until the instant of loading, when the loader, who carries these articles in a pouch, screws in a fulminate-cap and inserts the pin, previously feeling that the plunger does not stick. To keep the bursting-charge in place in the shell, a brass thimble, H, with a flange about the top, and small holes in the bottom, is first pressed into the fuse-hole and takes against the shoulder, D. A piece of cloth is pasted over the fire-holes in the bottom of the thimble. In this thimble the metal plunger rests. See *Fuse*.

GERMAN STEEL.—A metal made of charcoal-iron obtained from bog-iron or the sparry carbonate. See *Steel*.

GERMAN SYSTEM OF FORTIFICATION.—In the large additions made to the fortifications of the German States since 1815, the German engineers have for the most part of these new structures adopted for the plan of their enceintes the polygonal system with flanking caponieres, combining with these numerous casemates for defense, for bomb-proof shelters, for quartering the troops and preserving the munitions and other stores. The following appear to be the leading features upon which these works are based: 1. To occupy the principal assailable points of the position to be fortified by works which shall contain within themselves all the resources for a vigorous defense by their garrisons; these works being placed in reciprocal defensive relations with each other, but so arranged that the falling of one of them into the besieger's hands will neither compel the loss of the others, nor the surrendering of the position. These are styled *independent works*. 2. To cover all the space to the rear of these independent works either by a continuous enceinte, usually of the polygonal system, with a revetted scarp of a sufficient height to secure it from escalade; the parts of this enceinte being so combined with the independent works in advance that all the approaches of the besiegers upon each, both during the near and distant defense, shall be swept in the most effective manner by their fire; or else to connect these works by long curtains; or, finally, to employ them, as in a system of detached works, either to occupy important points in advance of the main work, or for forming capacious intrenched camps with a view to the eventualities of a war. 3. To provide the most ample means for an active defense by covered-ways strongly organized with casemated redoubts, and with spacious communications between them and the interior for sorties in large bodies. 4. So to organize the artillery for the near defense that it shall be superior to that of the besiegers at the same epoch, and be placed in positions where it will be sheltered from the besieger's guns up to the time that it is to be brought into play.

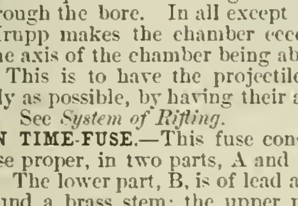
In the profiles of their works, the German engineers follow nearly the common rules for the forms and dimensions of their parapets. They employ three kinds of scarp revetments: 1. The ordinary full revetment, or sustaining wall, with counterforts. 2. Revetments with relieving arches, either with or without defensive dispositions, as circumstances may demand. 3. Scarp-walls either partly or wholly detached from the rampart and parapet. In all these cases, they give their scarp-walls a height from 27 to 30 feet for important works; and about 15 feet for those less so. The batter of these walls is usually one base to twelve perpendicular. For the full revetment with counterforts, they regulate the dimensions of both so as to afford the same stability as in the revetments of Vauban. In their revetments with simple relieving arches, they use either one or two tiers of arches; placing the single tier either near the top, or towards the middle of the wall, according to the nature of the soil and the pressure to be sustained. Revetments with relieving arches for defense, or scarp-galleries, are arranged for one or two tiers of fire. The back of the gallery is sometimes left open, the earth falling in the natural slope in the rear; or it is inclosed either with a plane or a cylindrical wall, according to the pressure to be sustained. When the upper part of the wall is detached, to form a corridor between it and the parapet in its rear, the top portion alone is, in some cases, arranged with loop-holes and arcades, or with recesses to their rear, to cover the men from shells; in others, a scarp-gallery is made below the floor of the corridor to give two tiers of fire. The corridors are from 8 to 20 feet in width; and when deemed requisite, they are divided, from distance to distance, by transverse loop holed traverse-walls for defense. When the scarp walls are entirely detached, they are arranged for either one or two tiers of fire, with arcades to cover the men; the banquette tread of the upper tier of loop-holes resting on the arches of the lower tier of arcades. The counterscarps are revetted either with the ordinary wall, or arranged with a defensive gallery with the full center arch, parallel to the face of the counterscarp-wall.

The plan of the independent works may be of any polygonal figure which is best adapted to the part assigned them in the defense of the position; but they are generally in the form of lunettes, having a revetted scarp and counterscarp to secure them from escalade. In the gorge of the work a casemated defensive barrack is placed, which serves as a redoubt or keep; a simple loop-holed wall which is flanked by the barrack closing the space between it and the flanks of the work, and securing the latter from an assault in the rear. The ditches of the work are either flanked from the enceinte in the rear; or, when the work is a detached one, by caponieres or counterscarp-galleries. The work is usually organized with a covered-way having one or more casemated redoubts, and a system of mines both for the exterior and interior defense. The defensive barrack is usually arranged for two or three tiers of covered fire, and an upper one with an ordinary parapet and terre-plein on which the guns are uncovered and destined for the distant defense. The two upper tiers of covered fire are for artillery, to sweep the interior of the work, and to reach by curvated fires the approaches on the exterior. The lower tier is loop-holed for musketry to sweep the interior. The barrack is surrounded by a narrow ditch on the interior, and this, whenever necessary, is flanked by small caponieres placed in it, which are entered from the lowest story. The barrack communicates with the interior by a door at some suitable point; and the communication between the interior of the work and the exterior is through doors in the wall inclosing the gorge. Considerable diversity is shown in the profiles of these works. They usually consist of a parapet and rampart of ordinary dimensions for the uncovered defense; of scarps either partly detached and loop-holed, with a corridor between them and the parapet; or of scarps with relieving arches arranged with loop-holes for musketry; or of a combination of these two. The height of the barrack, and the command of the parapet of the exterior work, are so determined that the masonry of the former shall be perfectly covered from the direct fire of artillery, and the exterior be perfectly swept by the artillery of the work. The portions of the counterscarps at the salients are also arranged with defensive galleries to sweep the ditches; usually with musketry, but in some cases with artillery.

Casemates are arranged for mortars in the salient angles of the work, to fire in the directions of the capitals; while one or more casemated traverses are placed on the terre-plein, to obtain a fire on the exterior and to cover the terre-plein from ricochet. The masonry of these traverses is masked by the parapet. Posterns lead from the interior of the work to the scarp-galleries, the corridors, the ditch-caponieres, and to the casemated mortar-battery in the salient. The systems of mines for the exterior defense consist simply of the listening-galleries leading outwards from the counterscarp-galleries. That for interior defense is similarly arranged; the communications with it being either from the barrack caponieres, or from the counterscarp of its ditch. The work is provided with powder-magazines which are placed at the points of the interior least exposed to the fire of the enemy; and covered guard-rooms, store-rooms for mining tools, etc., are made in connection with the posterns. The caponieres for flanking the main ditch usually consist of two faces and two casemated flank-batteries of two stories each; the lower story being loop-holed for musketry, and the upper pierced for artillery. Each battery consists of several rectangular chambers; each chamber for a single gun being 12 feet wide and 24 feet deep; or of smaller dimensions, according to the caliber of the gun and the kind of carriage on which it is mounted. The upper chambers are covered with bomb-proof arches, the lower one by arches of sufficient strength for the weight thrown upon them. The front mask-wall of the casemates is 6 feet thick; the wall in the rear is 3 feet thick, and is pierced with windows for light and ventilation. Openings for the escape of the smoke are also made in the front mask-wall immediately below the crowns of the arches. An interior court 30 feet in width is left between the two flank-batteries, and when the batteries are detached from the scarp-wall the space between is inclosed by a loop-holed wall built on each side in the prolongation of the front mask-wall. The faces of the caponiere form a salient of 60 degrees. They are separated from the flanks by two stories of arched corridors, in front of which are two arched chambers of two stories; the upper chamber being arranged for mortars. An open triangular court is left between the front walls of these chambers and the faces of the caponiere. The upper part of the walls of the faces along this court are arranged with arcades and loop-holed for musketry, and have an open corridor in their rear on the same level as the chambers of the second story. See *Polygonal System of Fortification* and *System of Fortification*.

GERMAN SYSTEM OF RIFLING.—In this system the grooves are thirty in number for all calibers, quite shallow, their sides being radial and forming sharp angles with the bore. The rifling has a uniform twist of one turn in 25 feet. The grooves are wider at the bottom of the bore than at the muzzle, so that the compression of the lead-coated projectile is gradual, and less force is expended in changing the shape of the projectile. The change of shape is effected by making the whole groove of the same size at the muzzle, and then cutting away gradually upon the loading-edge of the groove. Of course, as the twist is uniform, the driving-side of the groove cannot vary. The outer surface of the lead coating of the projectile is in raised rings with grooves between, to allow space for its being drawn down in passing through the bore. In all except his smaller calibers, Krupp makes the chamber eccentric with the bore, the axis of the chamber being above that of the bore. This is to have the projectile enter the bore as truly as possible, by having their axes nearly coincident. See *System of Rifling*.

GERMAN TIME-FUSE.—This fuse consists of the *body*, or fuse proper, in two parts, A and B, and the igniter, C. The lower part, B, is of lead and tin, and is cast around a brass stem; the upper part of this stem is provided on the inside and outside with screw-



German Time-fuse.

threads; into the inner thread is screwed the igniter, C; into the outer thread works a screw assembling-disk, which is prevented from turning when screwed down by a brass screw; at the bottom of the brass stem and projecting from its center is a sharp projecting pin. The stem has upon its exterior a grooved channel, and through it, near the point of the pin, radial holes, which permit the flame from the fulminate to communicate with the priming-chamber. The upper part, A, or the "regulator" of the fuse, is a ring of a truncated conical form; it has a priming-chamber and a circular groove on its under side, inclosing compressed mealed powder. The external opening of the chamber is covered by a thin strip of lead and tin, and the internal by a piece of paper. The rim of the "regulator" is divided into regularly-increasing spaces from 2 to 22, indicating meters and half-meters. Separating A and B is a washer of felt. A channel through the lower part of B, filled with rifle-powder, allows a communication between the burning composition of fuse and powder-charge of shell; the position of the upper opening of this channel is indicated on the rim of B by a triangular notch; the lower opening is closed by a disk of lead and tin, thin enough to be blown out by the rifle-powder. The igniter, C, is composed of four parts—the brass *stock*, which incloses all; the *screw cap*, which closes the end; the leaden-shouldered *plunger*, with its recess at bottom to receive the *fulminate wafer*. The fuse works as follows: At the instant of discharge, the plunger, by its own inertia, is forced back, shearing off the soft shoulders, and the fulminate strikes the projecting pin-point; the resulting gas escapes through the radial holes around this point and into a grooved channel, igniting the powder in the priming-chamber and circular groove, which burns till the channel of rifle-powder is reached, when the thin disk of metal at bottom of the channel is blown out, and the flame reaching the powder in the shell, explosion takes place. See *Fuse*.

GERRHES.—Shields used by the ancient Persians. They were usually made of wicker-work, and were rhomboidal in form.

GESATES.—Formerly the Gallic mercenary soldiers, who volunteered services beyond their native country. All these adventurers, or knights-errant, were called *Gesates*, either on account of the gese, or large dart, which they carried; or, as Polybius imagines, on account of the subsistence they received, which was called by that name. Also written *Gessates*.

GESES AND MATERES.—Weapons adopted by the Allobroges (a body of ancient Gauls), independently of the broad cut-and-thrust sword which the Swiss still wear. These instruments were only one cubit long; half the blade was nearly square, but it terminated in a round point which was exceedingly sharp. Not only the Romans but the Greeks received it into their armies. The former retained the full appellation and called it *gese*, but the latter corrupted it into *ysse*. The term *gese* was also applied to a sort of javelin. *Geserne* is the Anglo-Norman term for battle-axe. See *Gesates*.

GETÆ.—The people of Thracian extraction, who, when first mentioned in history, inhabited the country which is now called Bulgaria. They were a warlike people, and for a long time successfully resisted the attempts of Alexander the Great and Pyrrhus to subdue them. They afterwards removed to the north bank of the Danube, having the Dnieper as their boundary on the east, while westward they encroached on the Roman Empire, with which, from this time, they were continually at war. They were called Daci by the Romans, and their country Dacia, and are often mentioned in the literature of the Augustan Era as savage and unconquerable foes. During the reign of Domitian, they overcame the Romans, and exacted an annual tribute. But in 106, their gallant King, Decebalus, was defeated by Trajan, and the people completely subdued. A Roman Colony was settled in the country, and becoming incorporated with the Getæ, gave rise to a mixed race, the modern Wallachs.

GHENT TREATY.—A treaty between the United States and Great Britain which ended the war between the two countries known as the "War of 1812." The treaty was concluded December 24, 1814, two weeks before the battle of New Orleans. The main provisions were: 1st. Restoration of all territory, places, and possessions taken by either party from the other during the war, except certain Islands. Public property remaining in such places at time of ratifying the treaty was not to be destroyed or carried away, and the same promise was made for slaves and all private property. 2d. Article IV. provides the appointment of a Commission to decide to which of the two Powers certain Islands in and near Passamaquoddy Bay belong; and if the Commission should fail to come to a decision the subject is to be referred to some friendly Sovereign or State. 3d. Articles V. to VIII. provide for several Commissions to settle the line of boundary as described in the treaty of 1783—one Commission to settle the line from the river St. Croix to where the forty-fifth parallel cuts the river St. Lawrence (called the Iroquois or Cataraqua in the treaty); another to determine the middle of the water-communications from that point to Lake Superior; and a third to adjust the limits from "the water-communication between Lakes Huron and Superior to the most northwestern point of the Lake of the Woods." 4th. Article IX. binds both parties to use their best endeavors to abolish the slave-trade, as being "irreconcilable with the principles of humanity and justice." It is remarkable that the treaty fails to speak of the impressment of American seamen, a main cause of the war, and passes over the claims of the United States to participate in the fisheries, noticed in the treaty of 1783; nor does it conclude the question as to British and American naval forces on the northern lakes.

GHORCHANA.—The irregular Sikh yeomanry who served in the wars in the Punjab between the Sikhs and the English.

GHURRIE.—An Indian term; a circular plate of gun-metal, issued to troops in India, in the proportion of one per regiment, for the purpose of striking the hours. This kind of plate is made up in the country.

GIAMBEUX.—Greaves or an armor for the legs, made of metal or waxed leather, and much worn in the Middle Ages.

GIANT POWDER.—A mixture of nitro-glycerine with absorbents, by which this dangerously-explosive liquid is made into a perfectly safe solid substance, of a consistence and appearance not unlike light-brown sugar. It is not possible to explode this powder by ordinary accident, nor even by the application of a match. A quantity of it placed upon a rock and fired with a lighted match will burn away very much as a piece of camphor or resin would burn, with little flame but much smoke, and will boil and bubble until only a crust is left. There is not the least danger, therefore, of igniting the powder dangerously, until properly placed for the blast. In this respect it has a very great advantage over ordinary blasting-powder, which may be exploded by a spark. The powder, as it is manufactured, is made into cartridges about eight inches in length, and of any required diameter. The cartridges are wrapped in strong parchment-paper, and covered with paraffine. They are fired by a cap which is inserted into the end of the cartridge. The fuse, which is of the common kind, is inserted into the open end of the cap, which is pinched close upon it with a small pair of pliers, so as to hold it firmly. The cartridge is then opened at one end, the cap with the fuse attached inserted, and the paper is tied tightly around the fuse with a piece of twine. See *Dynamite* and *High Explosives*.

GIBERNE.—A sort of bag in which the grenadiers held their hand-grenades. It was worn like a powder-flask.

GILL COMBINATION-FUSES.—The metallic stock, A, of the fuse shown in Fig. 1 is open at both ends, the front half being bored conically to receive the time-fuse, B. At the bottom of the recess for fuse B is a small disk of metal, C, having a vent-hole, D, through its center; about one eighth of an inch below the disk C is a second and heavier one, E, having a central projecting point, F, on the under side; through this disk and equidistant from its center are three small holes. The space between disks is filled with pressed musket-powder, pieces of thin paper preventing its falling through holes in disks. The remainder of the stock, A, is bored cylindrically for the play of the triangular plunger, G, the hole through center of which is surmounted by a percussion-cap, H. On one of the triangular edges of the plunger, G, is a single stud running full length of plunger; both of the other edges have two studs, so arranged that the ones in front shall be in a different plane to insure freedom at impact. The cylindrical hole through the plunger is filled with pressed musket-powder and end stopped by a leather plug. A safety-pin secures the plunger in place. A metal pin, L, prevents the plunger from falling out, and a paper washer closes the rear end of stock. The fuse acts as follows: the time-fuse, B, cut for a certain number of seconds, is ignited at the instant of discharge by the gas from powder-charge, and the flame from fuse-composition ignites the pressed musket-powder between the disks C and E, which in turn ignites the bursting-charge of shell. Should, however, the flight of the projectile be arrested before the burning out of fuse-composition, the plunger, G, is thrown forward, the cap striking the projecting point, F, on disk E, igniting mealed powder in the center of plunger, G, thus igniting the bursting-charge and exploding the shell.

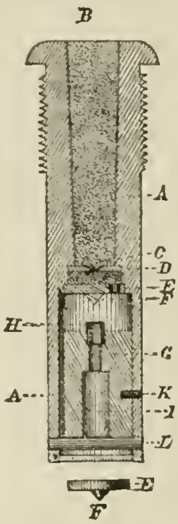


Fig. 1.

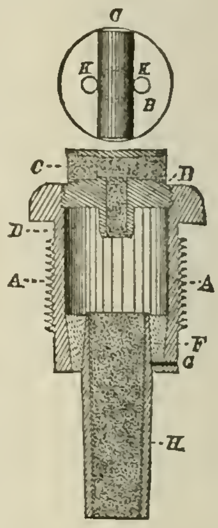


Fig. 2.

The fuse shown in Fig. 2 consists of a metal stock, A, open at the rear but closed at the front end by a screw-plug, B, having a transversal projection, C, on the out, and a central one, D, on the in side, both bored to form right-angled channels, which, when filled with pressed gunpowder, constitutes the igniter for time-fuse. At the bottom of the cylindrical pocket of the stock, A, there is a recess to receive the wedge-shaped, soft-metal valve or stopper-ring, F, which is held, after being pressed tightly into place, by two pins, G. The stock terminates in a slightly conical-shaped projection bored to receive and hold securely the time-fuse, H. The bottom of the recess for valve, F, is open, except at the three points or shoulders. The screw-plug, B, is provided also with two holes, KK, through which may be passed a strand of quick-match to insure ignition of time-fuse. The operation of the fuse is as follows: The gas from the burning powder-charge starts the igniter, which in turn ignites the time-fuse—cut as desired; should the shell's progress be arrested before burning out of fuse, the soft-metal ring is thrown forward, allowing gas from burning fuse free communication with bursting-charge in shell. See *Fuse*.

GILL DYNAMOMETER.—This instrument consists essentially of a hydraulic jack for producing pressure, and a system of levers and weights for recording same. There are two distinct methods of applying the pressure; one by hand, the other by the accumulator. Both methods involve the use of the jack; but in the first the pressure is intermittent, while in the second it is continuous. Automatic checks are arranged so as to relieve the pressure where the required effect has been produced. The combination leverage is 1 to 200. The capacity of the machine is 10,000 pounds, and any pressure up to that limit can be measured by the proper adjustment of the weights in the scale-pan and the slide on the graduated levers.

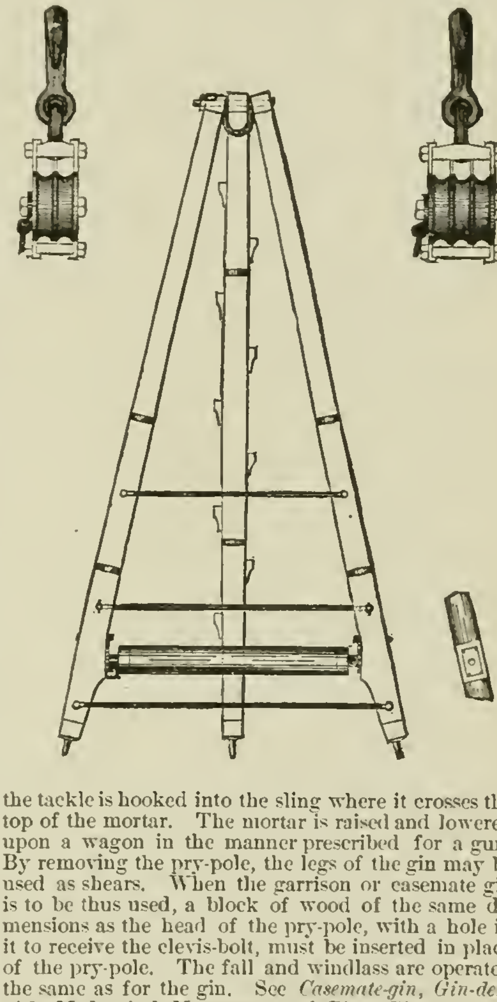
GIMBAL.—A mechanical contrivance for keeping a suspended body vertical, whatever be the derangements to which the points of suspension are liable. It consists of two brass rings which move within one another, each perpendicularly to its plane about two axes, placed at right angles to each other.

GIMLET.—A tool for boring holes in wood to receive nails, screws, etc., and generally used when the hole is to be larger than can be bored with a brad-awl. It has a conical screw-point, followed by a groove for clearing, and is fitted in a cross or T handle. An improvement has lately been made by twisting the grooved part of the gimlet, so that it forms a long spiral groove. A great variety of gimlets are used in the arsenal and laboratory.

GIN.—The gin is a tripod formed of three poles. Two of these poles, called legs, are joined together by braces of wood or iron, and contain between them the windlass. The third pole is called the pry-pole, and is joined to the legs, at the top, by a bolt. This bolt supports a clevis, to which the upper block of the tackle is hooked. The windlass is worked by two handspikes fitting into brass sockets, one at each extremity of the windlass; the operation of the handspike is made continuous by the action of a pawl attached to the socket on the ratchet of the windlass. To prevent the legs and pry-pole from sinking into the ground, or injuring the pavement of casemates, stout pieces of wood, called shoes, are placed under them. The hoisting apparatus consists of two blocks through which the fall is rove. The fall is wound two or more times around the windlass. There are three kinds of gins used for artillery purposes: the siege, the garrison, and the casemate. The last two differ from each other only in height; the first differs from the others in construction and size. Piper's gin is an improved modification of the siege-gin. When the gin is put together and raised, that part included between the legs and pry-pole is called the inside, the outside being the part without the legs; the right corresponding to the right hand of a man standing at the middle and outside of the windlass, facing towards it, the left corresponding to his left hand.

When mounting a siege-gun, it is immaterial upon which side of the piece the legs of the gin are placed, but for uniformity they are generally placed on the right. The gun is suspended either by a sling or by a bail; the latter is preferable. It consists of a stout piece of iron passing like a handle over the piece and fitting against the ends of the trunnions, to which it is fastened by iron bolts passing through the ends of the bail into holes bored for the purpose, one in the end of each trunnion. A clevis, attached to the middle of the bail, gives a place for hooking the lower block of the tackle. The piece may be conveniently slung by a rope passed around each trunnion, and the ends fastened together on top of the piece; or trunnion-rings may be used. Hook the pulley to this sling or to the trunnion-rings; bear down with one or two men on the handspike in the bore to balance the piece, and when it is raised sufficiently high run the carriage under it, and place a handspike in the trunnion-beds and a block on the stock. Lower the gun, the trunnions directly over the trunnion-beds, until the piece rests on the block and on the handspike. Remove the sling or rings from the trunnions, and run the carriage, with the gun on it, back until the head of the checks is in rear of a perpendicular let-fall from the head of the gin. Pass the sling around the chase, hook the pulley to it, and work the gin until the weight no longer bears on the handspike in the trunnion-beds; remove the handspike, and lower the trunnions to their places; bear down on the muzzle, and remove the block from under the breech

To sling and hoist a siege-mortar mounted on its carriage, a gun-sling or sling-chain is used. In either case, the middle of it is passed under the front notches; the ends carried up, and, crossing over the top of the mortar, are passed under the rear notches. The gin is erected over the mortar, and the lower block of



the tackle is hooked into the sling where it crosses the top of the mortar. The mortar is raised and lowered upon a wagon in the manner prescribed for a gun. By removing the pry-pole, the legs of the gin may be used as shears. When the garrison or casemate gin is to be thus used, a block of wood of the same dimensions as the head of the pry-pole, with a hole in it to receive the clevis-bolt, must be inserted in place of the pry-pole. The fall and windlass are operated the same as for the gin. See *Casemate-gin*, *Gin-derrick*, *Mechanical Maneuvers*, and *Piper Gin*.

GIN-DERRICK.—The garrison gin-derrick consists of two legs framed together, one pry-pole, two drums or windlasses with geared wheels, and two wagon-wheels, serving the double purpose of moving the derrick from point to point and for working the windlass. The axle passes through one of the windlasses, and can at pleasure be geared into a wheel on the other windlass. Length of legs, 254 inches; greatest width of legs, 86 inches; weight, 1725 pounds. It is hoisted by being pulled over to the front; the feet of the legs then rest on the ground, and the pry-pole is carried out over the object to be raised. The wheels are now free, and the method of operating the gin is similar to that for other gins, the power being applied to the wheels instead of to handspikes. See *Gin* and *Mechanical Maneuvers*.

GINDI.—The term applied to Turkish horsemen who perform extraordinary feats in horsemanship.

GINGAL.—A weapon used by Asiatic armies in the defense of fortresses. It may be described as a large and rude musket, which is fired from a rest. The Chinese employ it to a considerable extent. Also written *Gingaul* and *Ginjaul*.

GIONULES.—Turkish volunteer cavalry renowned for their bravery and excellent horsemanship.

GIRANDOLE.—1. In fortification, several chambers in mines connected for the defense of the place of arms of the covered-way. 2. Any firework turning upon a wheel, or any wheel whose circumference is studded with rockets.

GIRDER.—A main beam used to support joisting, walls, arches, etc. Girders may be of wood or iron, and are now very commonly made of cast-iron. They are much used in supporting the upper walls of houses, while the lower part is cut away to allow of rearrangement. Wooden girders are sometimes strengthened with iron trusses, and are then called trussed girders. Sometimes a beam is cut in two, and an iron plate inserted between the pieces, and the whole bolted together. This kind of girder is called a sandwiched beam. Girders are much used in railway and fortification works, in which case they are generally of wrought-iron. The Menai and Britannia bridges are simply very large boxed girders. The *lattice* girder is another form, in which the sides are made somewhat like wooden lattice-work.

GIRDLE.—A band of leather or of other material worn round the waist, either to confine the loose and flowing outer robes so as to allow freedom of movement, or to fasten and support the garments of the wearer. In southern Europe and in all Eastern countries the girdle was and still is an important article of dress. Among the Romans it was used to confine the tunica; and so general was the custom that the want of a girdle was regarded as strongly presumptive of idle and dissolute propensities. It also formed a part of the dress of the Greek and the Roman soldier; the phrase *cingulum deponere*, to lay aside the girdle, was as equivalent to quitting the service. It was used as now in the East to carry money in; hence *zonam perdere*, to lose one's purse. Girdles and girdle-buckles are not found in early Celtic interments, nor are they frequent in Gallo-Roman graves. But in Frankish and Burgundian graves they are almost constantly present, often ornamented with plaques of bronze or silver, and the clasps and mountings chased or inlaid with various ornamental designs, occasionally including figures of the cross, and rude representations of Scripture subjects. In later times girdles are frequently represented on brasses and monumental effigies from the twelfth to the sixteenth century. They were either of leather or of woven materials, often of silk and adorned with gold and gems. The mode in which they were worn is shown on the effigies; usually fastened by a buckle in front, the long free end of the girdle was carried up underneath and then down over the cincture, and through the loop thus formed the ornamented end hung down in front.

GIRL.—A term in Heraldry, used to signify the young of the roe in its second year. See *Heraldry*.

GIROLAMO MAGGI SYSTEM OF FORTIFICATION.—A system in which the bastions are small, and provided with double flanks. The curtain has four double flanks. Vauban borrowed from this system the curtain of his third system. See *Fortification*.

GIRONDISTS.—The name given during the French Revolution to the moderate Republican Party. When the Legislative Assembly met in October, 1791, the Gironde Department chose for its Representatives the advocates Vergniaud, Guadet, Gensonné, Grangeneuve, and a young merchant named Ducos, all of whom soon acquired great influence by their rhetorical talents and political principles, which were derived from a rather hazy notion of Grecian republicanism. They were joined by Brissot's party and the adherents of Roland, as well as by several leaders of the Center, such as Condorcet, Fauchet, Lasource, Isnard, and Henri La Rivière, and for some time had a parliamentary majority. They first directed their efforts against the reactionary policy of the Court, and the King saw himself compelled to select the more moderate of the party, Roland, Dumouriez, Clavière, and Servan, to be Ministers. Ultimately, however, he dismissed them, a measure which led to the Insurrection of the 20th June, 1792. The encroachments of the populace, and the rise of the Jacobin leaders, compelled the Girondists to assume a conservative attitude; but though their eloquence still prevailed in the Assembly, their popularity and power out of doors were wholly gone, and they were quite unable to prevent such hideous crimes as the September massacres. The principal things which they *attempted* to do after this—for they never succeeded in accomplishing anything—were to procure the arrestment of the leaders of the September massacres, Danton, etc.; to overawe the mob of Paris by a guard selected from all the Departments of France; to save the King's life by the absurdest of all possible means, viz., by first voting his death, and then by intending to appeal to the Nation; and, finally, to impeach Marat, who, in turn, induced the various sections of Paris to demand their expulsion from the Assembly and their arrestment. This demand, backed up as it was by one hundred and seventy pieces of artillery under the disposal of Henriot, leader of the Sans-culottes, could not be resisted; thirty of the Girondists were arrested on a motion of Couthon, but the majority had escaped to the Provinces. In the Departments of Eure, Calvados, and all through Brittany, the people rose in their defense, and, under the command of General Wimpfen, formed the so-called *Federalist Army*, which was to rescue the Republic from the hands of the Parisian populace. Movements for the cause of the Girondists took place likewise at Lyons, Marseilles, and Bordeaux. The progress of the Insurrection was, however, stopped by the activity of the Convention. On the 20th July the Revolutionary Army took possession of Caen, the chief station of the insurgents, whereupon the Deputies of the Convention, at the head of the Sans-culottes, forced their way into the other towns, and commenced a fearful retribution. On the 1st October, 1793, the prisoners were accused before the Convention by Amar, as the mouthpiece of the Committee of Public Safety, of conspiring against the Republic with Louis XVI., the Royalists, the Duke of Orleans, Lafayette, and Pitt, and it was decreed that they should be brought before the Revolutionary Tribunal. On the 24th their trial commenced. The accusers were such men as Chabot, Hébert, and Fabre d'Eglantine. The Girondists, however, defended themselves so effectually that the Convention on the 30th was obliged to come forward and decree the closing of the investigation. That very night Brissot, Vergniaud, Gensonné, Ducos, Fonfrède, Lacaze, Lasource, Valazé, Sillery, Fauchet, Duperret, Carra, Lehardy, Duchâtel, Gardien, Boileau, Beauvais, Vigée, Duprat, Mainvielle, and Antiboul were sentenced to death, and, with the exception of Valazé, who stabbed himself on hearing his sentence pronounced, all perished by the guillotine. On their way to the Place de Grève, in the true spirit of French republicanism, they sang the *Marseillaise*. Coustard, Manuel, Cussy, Noel, Kersaint, Rabaut St. Etienne, Bernard, and Mazuyer were likewise afterward guillotined. Biroteau, Grangeneuve, Guadet, Salles, and Barbaroux ascended the scaffold at Bordeaux; Lidon and Chambon, at Brives; Valady, at Périgueux; Dechézeau, at Rochelle. Rebecqui drowned himself at Marseilles, Pétion and Buzot stabbed themselves, and Condorcet poisoned himself. Sixteen months later, after the fall of the Terrorists, the outlawed members, including the Girondists Lanjuinais, Defermon, Pontécoulant, Louvet, Isnard, and La Rivière, again appeared in the Convention. A rather flattering picture of the party has been drawn by Lamartine, in his *Histoire des Girondins*.

GIRONNE—GYRONNE—GYRONNY.—Terms used in Heraldry to indicate that the field is divided into six, eight, or more triangular portions, of different tinctures, the points of the triangles all meeting in the center of the shield. Nisbet objects to this as a vulgar mode of blazoning; and, in speaking of the "paternal ensign of the ancient surname of Campbell," he says that it is "composed of the four principal partition-lines, parti, coupé, traunché, taillé, which divide the field into eight gironal segments, ordinarily blazoned with us, girony of eight, or, and sable." The triangle in dexter-chief has been called a giron or gyron.

GIRTH.—A band or strap made of web passing round the belly of a horse or other animal, to keep the saddle in its place. There is a girth known as the *Australian girth*, which is made of a network of hide or cord. It is very much approved of in the German army, and has been adopted by the cavalry of that Nation. It never gets saturated with sweat, and is therefore less likely to get stiff and hard, and hence causes fewer girth-galls. The term *girth* is also used with reference to the circumference of timber, etc.

GISARME.—This weapon is quite different from the *war-scythe* and *breach-knife*, as it is double-edged, like the cut-and-thrust sword, and armed with hooks. Its origin dates from the Age of Bronze among the Keltic and Germanic Nations, at which time many tribes were in the habit of fastening glaives or scramas-axe swords to very long shafts. Frequently called *glaive-gisarme*. See *Guisarme*.

GISTES.—Pieces of wood which are made use of in the construction of platforms to batteries, and upon which the madriers or broad planks are placed.

GLACIS.—In fortification, the slope of earth, commonly turfed, which inclines from the covered-way towards the country. Its object is to bring assailants, as they approach, into a conspicuous line of fire from the parapet of the fortress, and also to mask the general works of the place.

In the fortifications like Noizet's, one principle is chiefly to be attended to in disposing the different planes of the glacis. They should all be swept by the artillery-fire of the works immediately in their rear, and by the musketry-fire at least of the bastion-face. The glacis of the bastion covered-way should be swept by the artillery of the bastion-face. The glacis of the re-entering place-of-arms should be swept by the fire from its redoubt. The glacis of the demi-lune offers more difficulty in its arrangement, owing to the crémaillère form of the interior crests. The best method seems the following: Planes are passed through each long branch, so as to be swept by the artillery-fire of a portion of the face of the demi-lune; these are connected by another series of planes, which are passed through the salient point of each crotchet, and below the plane of musketry-fire of at least one half of the bastion-face, and that of artillery-fire of a part of the demi-lune face. It will be readily seen, from the nature of this problem, that it admits of many solutions. In selecting amongst them, the following considerations may serve as guides: 1. When the planes of the glacis have a very gentle slope, they are better seen by the works in their rear; but the construction is more expensive, on account of the greater quantity of embankment. 2. When the slope is more steep, the enemy's works on the glacis are better exposed to the reverse views of the collateral works, although not so well seen by those directly in rear of the glacis; but the quantity of embankment is smaller. See *Fortification*.

GLADIATOR.—In antiquity, from *gladius*, a sword, one who fought in the arena, at the Amphitheater at Rome, and in other cities, for the amusement of the public. The gladiators were generally slaves, bought and trained for the purpose, by masters who made this their business. The custom is supposed to have been borrowed from the East, and to have had its origin in the practice of human sacrifices, or that of taking the lives of captives or prisoners of war, in honor of heroes who had died in battle. Thus, in the *Iliad* we read that Achilles sacrificed twelve Trojan prisoners to the manes of his friend Patroclus, and Virgil speaks of captives sent to Evander, to be sacrificed at the funeral of his son Pallas. The "Great Custom" of the King of Dahomey thus finds warrant in classic antiquity; and the North American Indians, in putting their prisoners to death with tortures, have only refined upon an ancient barbarism. After a time, all funerals were solemnized by human sacrifices, which took the form of combats, in which, to increase the interest of the spectators, the prisoners were required to sacrifice each other; and as prisoners, and afterwards other slaves, were kept for this purpose, they were trained to fight with skill and courage, to make the spectacle more impressive. These contests first took place at funerals, but afterwards in the Amphitheater; and in process of time, instead of a funeral rite, became a common amusement. The first we read of in Roman history was the show of a contest of three pairs of gladiators, given by Marcus and Decius Brutus, on the death of their father, in the year of Rome 490. In the year 537 a show of twenty-two pairs was given in the Forum. In 547 the first Africanus diverted his army at New Carthage with a gladiatorial exhibition. The fashion now rapidly increased. Magistrates, public officers, candidates for the popular suffrages, gave shows to the people, which consisted chiefly of these bloody and generally mortal encounters. The Emperors exceeded all others in the extent and magnificence of these cruel spectacles. Julius Cæsar gave a show of 320 couples; Titus gave a show of gladiators, wild beasts, and sea-fights for 100 days; Trajan gave a show of 123 days, in which 2000 men fought with and killed each other, or fought with wild beasts for the amusement of the 70,000 Romans, Patricians and Plebeians, the highest ladies and the lowest rabble, assembled in the Colosseum. A vast number of slaves from all parts of the world were kept in Rome, and trained for these exhibitions. There were so many at the time of Catiline's Conspiracy, that they were thought dangerous to the public safety, and it was proposed to distribute them among the distant garrisons. Efforts were made to limit the number of gladiators, and diminish the frequency of these shows. Cicero proposed a law, that no man should give one for two years before becoming a candidate for office. The Emperor Augustus forbade more than two shows in a year, or that one should be given by a man worth less than half a million sesterces; but it was difficult to restrain what had become a passion, and men even had such contests for the amusement of their guests at ordinary feasts. These shows were announced by show-bills and pictures, like the plays of our theaters. The gladiators were trained and sworn to fight to the death If they showed cowardice, they were killed with tortures. They fought at first with wooden swords, and then with steel. When one of the combatants was disarmed, or upon the ground, the victor looked to the Emperor, if present, or to the people, for the signal of death; if they raised their thumbs, his life was spared; if they turned them down, he executed the fatal mandate. A gladiator who had conquered was rewarded with a branch of palm, and sometimes with his freedom. Though the gladiators at first were slaves, freemen afterwards entered the profession, and even knights. Senators and knights fought in the shows of Nero, and women in those of Domitian. The Emperor Constantine prohibited the contests of gladiators, 325 A.D.; but they could not at once be abolished. In the reign of Honorius, Telemachus went into the arena to stop the fight, when the people stoned him. They were finally abolished by Theodoric, 500 A.D.

GLADIUS.—A Roman sword with a single cutting edge, and having a grooved blade. See *Gladiator*.

GLANDERS.—A malignant disease of the equine species, characterized by the appearance within the nostrils of little holes or ulcers, remarkable for their rugged, inflamed, undermined edges, their discharge of sticky, greenish, unhealthy pus, their tendency to spread, and their resistance of treatment. The blood of glanderous subjects is deficient in red globules, contains an excess of albumen and fibrine, and in this vitiated and deteriorated state is inadequate properly to nourish the body, which consequently becomes weak and wasted. The mucous membranes are also irritable and badly nourished; there is consequently impaired respiration, an obstinate choking cough, and relaxed bowels. The lymphatic glands and vessels become inflamed, and in their swollen state may be distinctly felt about the throat and underneath the jaws, and also in the limbs, where they frequently run on to ulceration, constituting farcy. Glanders is produced by any cause which interferes with the purity or integrity of the horse's blood, or produces a deteriorated or depraved state of his system. It has been frequently developed in healthy animals by their breathing for a short time a close, impure atmosphere, and cases of this sort were thus produced amongst the horses of several cavalry regiments, whilst being transported in badly-constructed, overcrowded vessels to the Crimea in 1854. Confined, overcrowded, badly ventilated stables are almost equally injurious, for they prevent the perfect aëration of the blood, and the prompt removal of its organic impurities. Bad feeding, hard work, and such reducing diseases as diabetes and influenza also rank amongst the causes of glanders. A small portion of the nasal discharge from a glandered horse coming in contact with the abraded skin of man, communicates the loathsome and fatal disease from which so many attendants of horses have died, and Government very properly compels the immediate destruction of every glandered horse. Whilst oxen and dogs are exempt from it, donkeys suffer generally in the acute form, often dying in eight or ten days. Horses frequently have it in a chronic form, and if well fed and managed sometimes live and work for years. In the old coaching-days some stages were known to be worked by a glandered team, but no animal with glanderous ulcers or discharge should on any account be preserved, for, besides being perfectly incurable, the fatal disease is communicable not only to healthy horses, but also to human beings. See *Veterinary Art*.

GLAIRE.—A broad-sword or falchion fixed upon a pike. The name is sometimes applied to the weapon used in the days of knighthood, and to that used for executions.

GLAIVE.—A modified form of the *war-scythe*. The blade of the weapon curves from the edge and has a hook or spur at its base. The point is double-edged. The glaive was much used in France during the fourteenth century, and is especially mentioned in the poem of the "Trente." Also written *Glare*.

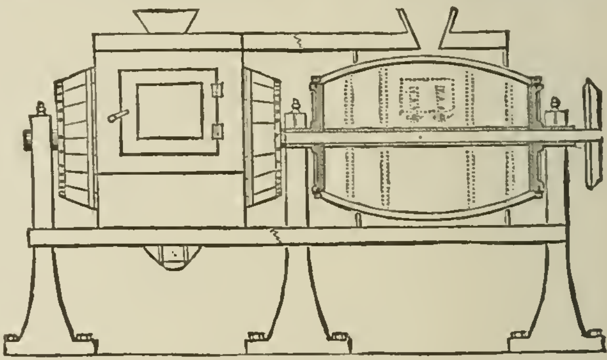
GLAIVE-GISARME.—This weapon, which British authors usually confound with the halberd, is simply a *glaire* fixed on a shaft, or a *gisarme*. See *Gisarme*.

GLAIZE.—A kind of halberd, much used by the Saxons in early times, and by whom so called.

GLASSER SYSTEM OF FORTIFICATION.—A system having a bastioned enceinte, ravelins with reduits, counter-guards, envelope, and re-entering places-of-arms with reduits. The ramparts have a demi-revetment with a chemin-des-rondes or fausse braye on the level of the ground. On the capitals of bastions and ravelins are casemated caponieres, which are well covered and powerfully defend the ditches.

GLASS-PAPER.—A polishing material made by powdering glass more or less finely, and sprinkling it over paper or calico still wet with a coat of thin glue; the powdered glass adheres as it dries. Glass-paper is very extensively employed as a means for polishing metal and wood-work; it is sold in sheets, and is very largely manufactured at Birmingham and other places.

GLAZING-BARREL.—Some manufacturers glaze or polish large-grain powder by using a small quantity of black-lead, about half an ounce to every 100 pounds of powder. The black-lead, with the powder in these proportions, is put into a glazing-barrel, and from three quarters of an hour to one hour is found to be sufficient time to polish the grain. Black-lead is also sometimes used with the small or fine-grain powder; but, although its use has some advantages, such as lessening the formation of dust, and also preventing the moisture in the atmosphere from affecting the powder so readily, still it is an impurity, and as such should be used sparingly and with much caution. Recently plumbago has been used for glazing gunpowder, and if obtained pure is preferred to black-lead, inasmuch that while a little more than half the quantity is sufficient to give a perfect glaze to the powder, it is found to protect it more effectually from the action of moisture in the atmosphere. The glazing apparatus consists of a large strong wooden barrel supported, as shown in the drawing, on an iron shaft which runs through the center. The barrels, two of which are generally placed in line on one shaft, are formed of oak, and are about 5 feet long and 2½ in diameter; the shaft is cased with wood where it passes through the barrels. Each barrel is provided with a small square door for charging and uncharging. The barrels are found to be peculiarly well



Glazing Apparatus.

adapted for the purpose, owing to their shape. Formerly wooden cylinders with straight sides were used, but it was found that the different sizes of grain had a tendency to separate in them, so that all did not receive an equal amount of polishing. But in the barrels, which are larger in diameter at the center, there is a constant intermingling of the grain and a more uniform action. A set of glazing-barrels consists of four, each pair being supported on a shaft. These shafts are of wrought-iron, covered on the inside of the barrels with wood, and receive their motion by means of bevel gearing direct from a main shaft driven by the water-wheel or steam-engine. The barrels are inclosed in wooden casings, with feeding-hoppers on the top. Into each hopper four casks of fine-grain powder (each cask containing 100 pounds) are emptied, the barrels are turned with their doors uppermost, and the contents of the hoppers pass into them; the doors are then closed and secured. The apparatus is now set in motion, and after running for five or six hours it will be found that a fine gloss has been imparted to the powder by the mere friction of the grains rubbing one against the other, whilst at the same time all the sharp angles and corners are rubbed off, and the powder thereby rendered much better for keeping or for transport. Each pair of barrels can be stopped or put in motion at pleasure, independently of the others, by simply throwing a clutch in or out of gear, so that after the barrels have been at work a sufficient time this clutch is thrown out, and they are brought to rest with their doors downwards. Upon these being unfastened and opened, the powder is delivered into casks already placed for its reception. This operation, as may be imagined, produces a small quantity of dust, which is removed by passing the glazed powder once through a slope-reel kept expressly for the purpose. The fine-grain powder is now in the same state as the large-grain powder. Both contain about the same degree of moisture, which it is necessary to extract before the powder is complete and fit for sending into store; this is effected in the drying-stove, where both the fine and large-grain powder can be dried at one and the same time. See *Gunpowder*.

GLISSADE.—The term formerly applied to the forward or backward movement of the pike.

GLOBE OF COMPRESSION.—The phrase *common mine* is applied to the crater when its radius is equal to the line of least resistance. When the crater radius is greater than the line of least resistance, the terms *overcharged mine* and *globe of compression* are used. When the crater radius is less than the line of least resistance, the mine is termed *undercharged*.

GLOBE-SIGHT.—A form of front sight used mostly on target and sporting rifles. It consists of a pin with

Globe-sights.

a small ball on the end of it, or a disk with a hole in it. For protection it is set in a tube open at both ends. The sight, with interchangeable disk, is represented in the drawing. See *Front Sight*.

GLOIRE.—An artificial fire-work of great splendor which resembles a large sun.

GLORIOUS VIRGIN.—An Order of Knighthood in Venice, founded by Bartholomew of Vicenza, and approved by Pope Urban IV. in 1262. This institution was ecclesiastical as well as military, and its objects were the protection of widows and orphans, and the furtherance of the peace of Italy. The badge was a purple cross between certain stars, and the costume a white surcoat on a russet cloak.

An Order of Knighthood of St. Mary the Glorious also existed in Rome about the seventeenth century, whose purpose was the suppression of the Barbary Corsairs who infested the Mediterranean.

GLORY.—The honor, reputation, and fame acquired by military achievements. That precarious splendor which plays around the brows of a warrior, and has been collected by hard service, extraordinary genius, and unblemished integrity; but which may desert the greatest hero through one unfortunate failure, occasioned by the fatality of human imperfection.

GLOVES.—Covers for the hands, or for the hands and wrists, having a separate sheath for each finger. Gloves are worn by all officers and soldiers when under arms or when wearing side-arms. In the United States army they are prescribed as follows: *For General Officers, Officers of the General Staff, and Staff Corps.*—Buff or white gauntlets or gloves. *For Field Officers of Artillery, Cavalry, and Infantry; for the Officers of Light Artillery and Cavalry.*—White gauntlets or gloves. All other officers and enlisted men, white gloves. *To throw the glove* is the old expression which formerly meant to challenge to single combat.

GLUE.—An impure desiccated gelatine, procured from various sources, such as the scraps of ox and other thick hides, the débris of tan-yards, the tendons and intestines of many animals, rabbit-skins deprived of their fur, scraps of parchment, old gloves, and many other apparently worse than useless matters, all contributing their portion in the manufacture of "glue." Glue is an invaluable article in the laboratory and arsenal. It differs only from *gelatine* in the care taken in its manufacture, and in the selection of the materials from which it is made; almost every animal substance will yield it, hence all kinds of animal refuse find their way to the glue-makers' boilers. Nevertheless, the impossibility of preserving for any length of time the materials required for this manufacture renders it necessary to adopt some system in choosing and preserving them, until sufficient quantities are collected, without fermentation or decomposition. Hence the refuse of tanneries, consisting of the clippings of hides, hoofs, ear and tail pieces of ox, calf, and sheep, are preferred, because they can be dressed with lime, which removes all the hair and acts like an antiseptic. For this purpose they are placed in tanks with quicklime and water for two or three weeks, during which the lime is several times renewed, and the pieces frequently turned over. They are afterwards washed and dried, and are ready for use by the glue-maker, who usually gives them another slight lime-dressing, and subsequently washes them; they are afterwards exposed to the action of the air for a while, to neutralize the caustic lime. When well drained, the pieces are placed in flat-bottomed copper boilers, which have a perforated false bottom placed a little distance above the true one, to prevent the burning of the materials, and which have been supplied with rain or other soft water up to two thirds the depth of the boiler, the pieces being piled up to some height above the top of the open boiler. The whole is kept at a gentle boiling heat until all the gelatinous part has dissolved out, and the mass of material has sunk down into the fluid. The boiling is sustained until, by repeated trials of small quantities, the operator knows the fluid is of the right consistency, when it is drawn off carefully into the congealing boxes, and fresh materials are added to the residue left behind in the boiler, and the process is repeated.

Besides its use in joinery, in cabinet-making, and similar operations, glue is used by paper-makers and in dressing silks; and for these last two purposes fine light-colored kinds in thin cakes are made. Large quantities are employed also for sizing walls in the state called *size*, which is the glue simply gelatinized after boiling in the first process. A very fine and pure white *size* is made by the bonnet-makers of Bedfordshire and other places of the skins of calves' head, ears, and the under part of the neck and belly; this is employed for stiffening straw, cotton, horse-hair, and other plaits for making bonnets and hats.

GLYACYLINE.—An explosive substance composed principally of gun-cotton and nitro-glycerine. See *Nitro-glycerine*.

GNOMON.—The hand of a sun-dial. It is placed at such an inclination with the plate of the dial that, when properly set, the gnomon will be directed to the north pole of the heavens, and its shadow will fall upon the same lines of the dial at the same hours, whatever be the season of the year—that is, for one particular latitude; but dials must be differently constructed for places which have different latitudes. It is shown in Astronomy that the elevation of the celestial pole is equal to the latitude of the place, and, consequently, the inclination of the gnomon of a sun-dial must be also equal to the latitude of the place where the dial is intended to be set. It follows, therefore, that a dial constructed for London would not be suitable for Edinburgh.

GOAT'S-FOOT CROSS-BOW.—A form of cross-bow anciently used by the cavalry. It was much lighter than the infantry cross-bow, and the string was always stretched by means of a simple lever, called a *goat's foot*.

GOBILLE.—A small copper ball, one fourth of an inch in diameter, several of which are put into a revolving cask for the purpose of more intimately incorporating the ingredients of powder, carcass, and rocket-composition.

GOBISSON.—A quilted and padded dress worn under the habergeon. Also written *Gambasson*.

GOBONY.—A term in Heraldry, the same as *componé*. A gobonated bordure is frequently carried in place of the baton sinister, not only by the lawful issue of bastards, who, after the third lawful generation, are considered entitled to make the change, but by bastards themselves. See *Bastard Bar*.

GOD SAVE THE QUEEN.—The national anthem of Great Britain, and by adoption that of several of the German States, and which is played and sung in every part of the British Empire alike on solemn and festive occasions, has been a subject of controversy with respect to its origin. Its words are apparently imitated from the Domine Salvum of the Catholic Church Service. In England the authorship has been generally attributed to Dr. John Bull, born 1563; in 1591 Organist in Queen Elizabeth's Chapel; 1596, Professor of Music in Gresham College, and Chamber-musician of James I. About the period of the discovery of the Gunpowder Plot, Bull composed and played on a small organ before the King an ode beginning with the words, "God save great James our King." He died at Lübeck, 1622. It does not appear, however, that this or any other old composition of a similar title had any connection with that which we now possess. The words and music were composed in honor of a birthday of George II., and performed for the first time at a dinner given on that occasion in 1740 by the Mercers' Company of London. The words and music were first published in the *Harmonia Anglicana*, 1742, and appeared in the *Gentleman's Magazine*, 1745. The air, according to Dr. Arne, has preserved its original form, but its harmonies have been modified by various artists; and the words were changed on the accession of William IV., and on that of Queen Victoria.

GOLADAR.—An East Indian term signifying a sutler or store-keeper. Also written *Goldar*.

GOLANDAAZEE.—The Indian term for an artilleryman. Also written *Golandanzee* and *Golundanzee*.

GOLD-BEATER'S SKIN.—The prepared external membrane of the large intestine of the ox, frequently used to protect primings and fuse-compositions from dampness, as in the construction of the Breithaupt fuse.

GOLD-COAST CORPS.—A corps in the British service made up of drilled Africans, and officered from the West India regiments. It is kept up for the purpose of protecting the possessions of Sierra Leone and Gambia.

GOLDEN EAGLE.—The typical eagle and imperial emblem of ancient Rome and Persia. It is generally of brown color, and about 3 feet long.

GOLDEN FLEECE.—In Greek tradition, the fleece of the ram Chrysomallus, the recovery of which was the object of the Argonautic expedition. The Golden Fleece has given its name to a celebrated Order of Knighthood in Austria and Spain, founded by Philip III., Duke of Burgundy and the Netherlands, at Bruges, on the 10th January, 1429, on the occasion of his marriage with Isabella, daughter of King John I. of Portugal. This Order was instituted for the protection of the Church, and the fleece was probably assumed for its emblem, as much from being the material of the staple manufacture of the Low Countries as from its connection with heroic times. The founder made himself Grand-Master of the Order, a dignity appointed to descend to his successors; and the number of Knights, at first limited to 24, was subsequently increased. After the death of Charles V., the Burgundo-Spanish line of the House of Austria remained in possession of the Order; but at the close of the Spanish War of Succession, the Emperor, Charles VI., laid claim to it in virtue of his possession of the Netherlands, and taking with him the archives of the Order, celebrated its inauguration with great magnificence at Vienna in 1713. Philip V. of Spain contested the claim of Charles; and the dispute, several times renewed, was at last tacitly adjusted by the introduction of the Order in both countries. The insignia are the golden fleece hanging from a gold and blue enameled flintstone emitting flames, and borne in its turn by a ray of fire. On the enameled obverse is inscribed *Pretium laborum non vile*. The decoration was originally suspended from a chain of alternate firestones and rays, for which Charles V. allowed a red ribbon to be substituted, and the chain is now worn only by the Grand-Master. The Spanish decoration differs slightly from the Austrian. The costume consists of a long robe of deep red velvet, lined with white taffetas, and a long mantle of purple velvet lined with white satin, and richly trimmed with embroidery containing firestones and steels emitting flames and sparks. On the hem, which is of white satin, is embroidered in gold, *Je l'ay empris*. There is also a cap of purple velvet embroidered in gold, with a hood, and the shoes and stockings are red. In Austria, the Emperor may now create any number of Knights of the Golden Fleece from the old nobility; when Protestants, the Pope's consent is required. In Spain, Princes, Grandees, and personages of peculiar merit are alone eligible.

GOLDEN HORDE.—A force of Tartars who invaded Kiev and Moscow, destroyed several other cities, and in 1241 massacred a Magyar army. Their first leader was the grandson of Genghis Khan. At the battle of Bielawisch, in 1481, they were destroyed by Ivan III. and the Nogay Tartars.

GOLD RAIN.—An ornament for rockets formed of small stars, all of the same size. These stars are cubes, the length of the side being .5 inch. The composition consists of 16 parts of niter, 10 parts of sulphur, 4 parts of mealed powder, 3 parts of lamp-black, 1 part of flowers of zinc, and 1 part of gum arabic. The sodium nitrate may be replaced by the bicarbonate of soda or the oxalate of soda. The copper sulphate is well ammoniated. See *Compositions* and *Fire-works*.

GOLD STICK.—Superior Officers in the English body-guard, and Captains in the Corps of Gentlemen-at-Arms; so called because on state occasions they carry a gilded bâton.

GOLLETTE.—A shirt of mail worn by foot-soldiers in ancient times. See *Armor* and *Hauberk*.

GOMER CHAMBER.—This chamber, named after its inventor, consists of the frustum of a cone connected with the bore by a portion of the surface of a sphere. This kind of chamber is considered very advantageous for mortars. Being large at the mouth, it allows the powder to act on an entire hemisphere of the projectile, and no risk is run of breaking it. It, however, gives a less range than either the cylindrical or spherical, but its capacity is greater.

GONFALON.—1. One of the arms borne by the Normans in the eleventh century. It was a spear, sometimes ornamented with a small flag, fixed just below the metal point, and similar to the present English lance.—2. An ensign or standard.

GONFALONIER.—A Turkish General and Standard-keeper who always precedes the Grand Seignior during war.

GONG.—An Indian instrument of percussion, made of a mixture of metals (78 to 80 parts of copper, and 22 to 20 parts of tin), and shaped into a basin-like form, flat and large, with a rim a few inches deep. The sound of the gong is produced by striking it, while hung by the rim, with a wooden mallet, which puts the metal into an extraordinary state of vibration, and produces a loud, piercing sound. It is used by the Chinese as an instrument of martial music.

GONGWALLAS.—A term applied to the Militia in India. It is thus called from *Gong*, a village, and *Wallas*, a man.

GOOD-CONDUCT BADGES.—Marks of distinction for good conduct which are bestowed upon soldiers in the English army. Each badge carries with it a reward of a penny a day. The badges are worn by soldiers below the elbow, with the points up.

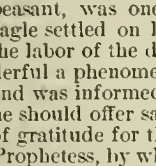
GOOD-CONDUCT PAY.—A reward of additional pay to corporals and private soldiers for good conduct. It is granted under the following circumstances: A soldier whose name does not appear in the regimental defaulter-book for at least two years preceding his claim receives—after 2 years, 1*d.* per diem, with one good-conduct badge; after 6 years, 2*d.* per diem, with one additional badge for each penny: after 12 years, 3*d.* per diem; after 18 years, 4*d.* per diem; after 23 years, 5*d.* per diem; after 28 years, 6*d.* per diem. A soldier of 16 and less than 18 years' service, and whose name has not been entered in the regimental defaulter-book for 14 years next preceding the date at which he shall become entitled thereto, shall receive the rate granted by Article 911 of the Warrant, after 18 years' service, on completion of such 14 years' continuous good conduct; and shall receive the rate attached to 23 and 28 years after 21 and 26 years respectively. The Warrant further states that a soldier shall not be advanced to a higher rate of good-conduct pay unless he shall have been in the uninterrupted receipt of the next lower rate for the two years immediately preceding his claim. But this condition shall not apply to the accelerated rates specified in Article 914. Non-commissioned officers do not receive good-conduct pay, but receive instead 2*d.* a day as an increase to their regular pay. They receive, as well, rewards for distinguished or meritorious services, annuities and medals, either while serving or after discharge. A Warrant, dated May 29, 1875, has been issued by the Secretary of War, revising the regulations contained in the Warrant of December 27, 1870, relative to the forfeiture of the service of soldiers, and to amend in certain respects the regulations relative to good-conduct pay.

GOOD-SERVICE PENSION.—An annuity of £100 a year given to General or Field Officers in the English army as a reward for distinguished or good service. Only a certain number of annuities is granted. This reward is held either for life or until an officer succeeds to his Colonel's Allowance.

GOODWIN COEHORN.—A small Coehorn mortar fixed on a stake driven into the ground at a suitable angle, and fired by a trigger and a lanyard. It is a surprisingly effective little piece, throwing a 3-inch shell to a very great distance, and may be carried one under each arm.

GORDIAN KNOT.—The traditional origin of this famous knot was as follows: Gordius, a Phrygian peasant, was once plowing in his fields, when an eagle settled on his yoke of oxen, and remained till the labor of the day was over. Surprised at so wonderful a phenomenon, he sought an explanation of it, and was informed by a Prophetess of Telmissus that he should offer sacrifice to Zeus. He did so, and out of gratitude for the kindness shown him married the Prophetess, by whom he had a son, the famous Midas. When Midas grew up, disturbances broke out in Phrygia, and the people sent messengers to the oracle at Delphi, to ask about choosing a new King. The messengers were informed that a King would come to them riding on a car, and that he would restore peace. Returning to Phrygia, they announced these things, and, while the people were talking about them, Gordius, with his father, very opportunely arrived in the requisite manner. He was immediately elected King, whereupon he dedicated his car and yoke to Zeus, in the acropolis of Gordium (a city named after himself), the knot of the yoke being tied in so skillful a manner that an oracle declared whoever should unloose it would be Ruler of all Asia. When Alexander the Great came to Gordium, he cut the knot in two with his sword, and applied the prophecy to himself.

GORE.—In Heraldry, a charge consisting of one third of the shield cut off by two arched lines, one drawn from the dexter or sinister chief, and the other from the bottom of the escutcheon, meeting in the fess point. A gore sinister is enumerated by Heralds as one of the abatements or marks of dishonor borne for unknightly conduct. See *Gusset* and *Heraldry*.

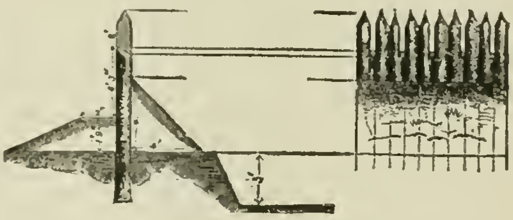


Gore.

GORGE. — 1. A cavetto, hollow member, or round concave molding, containing the quadrant of a circle, and used as an ornament in cornices. The term is commonly applied to the entrance into any piece of a fortification, which consists of the distance or space between the inner extremities of the two faces. See *Gorge of Mountains.*

2. In fortification, the opening on that side of the work corresponding to the body of the place, or the side whence comes the defense. In isolated works, the gorge is sometimes intrenched. The gorges of works not attached to a fortress, but which are its dependencies, are in general open, or without parapets, in order that the enemy may not cover himself from the fire of the place if he should seize such detached works. If the works are liable to surprise, and their gorges cannot be shut, a row of palisades are planted there, and mines are prepared so as to overthrow the enemy if he should seize the work and attempt to construct a lodgment there. The gorge of a bastion is usually an open space between the extremities of the flanks of the bastion. The larger this gorge is, the better is the defense; for when the ruined bastion is about to fall by siege into the hands of the enemy, the defenders can construct defensive works or dig small ditches in the gorge of the abandoned bastion. Such resistance sometimes drives the besiegers to the necessity of battering in breach the curtain.

A stockade is the best inclosure for the gorge of a work. The outline or plan of the gorge should be



Section and Elevation of Stockade of Gorge.

a small bastion front, or a tenaille, for the purpose of obtaining a flank defense. The trunks for the stockade should be ten or twelve inches in diameter and eleven feet in length. It will be best to square them on two sides, so that they may have about four inches of surface in contact. The top of the stockade should be at least eight feet above the ground. To arrange it for a defense, a banquette is thrown up against it on the interior; the height of the banquette one foot nine inches. A strip about two feet in length should be cut from the top of two adjacent trunks with a saw, so that when they are placed side by side there shall be an opening at top, between them, eight inches wide on the interior and two and a half inches on the exterior; this opening, through which the muzzle of the musket is run out in firing, is termed a *loop-hole.* The distance between the loop holes should be three feet. In this arrangement the bottom of the loop-holes will be six feet above the ground on the exterior, to prevent the enemy from closing on them to stop them up or use them in the attack. About four feet in front of the stockade a ditch is made, twelve feet wide and three feet deep. The earth from the ditch is thrown up against the stockade, in a slope, to the level of the bottom of the loop-hole, to prevent the enemy from attempting to cut down the stockade.

GORGED.—When a lion or other animal has a crown by way of collar round its neck, it is said heraldically to be gorged.

GORGE OF MOUNTAINS.—The passage, more or less compressed, between two mountains, which is used as a passage-way into valleys. Gorges are important military points. If they lead to an intrenched camp, it is necessary to fortify them, and there post grand guards; these positions are the principal theaters for affairs of posts.

GORGERIN.—A portion of armor at the bottom of the helm and below the *barière*. It was used instead of the mail camail to protect the neck. See *Gorget*.

GORGET.—That part of the ancient armor which defended the neck. Also a crescent-shaped ornament formerly worn by military officers on the breast. The gorget ceased to be worn, like other articles of body-armor, during the reign of Queen Anne.

GORGONS.—In military antiquity, a warlike female nation of Libya, in Africa, that had frequent quarrels with another nation of the same sex, called *Amazons*.

GOTHS.—The name of a powerful nation of antiquity, belonging to the Germanic race. By some writers they are thought to have had a Scandinavian origin, which was the belief of their own historian, Jornandes. Indeed, Jornandes, Procopius Capitolinus, and Trebellius Pollio identified them with the Getæ, a branch of the Thracian group of nations; but later researches, especially those of Dr. Latham, leave it almost without a doubt that the Goths were originally Germans. The earliest notice of them extant among the writers of antiquity is that of Pytheas of Marseille, who lived about the time of Alexander the Great, and wrote a book of travels, some fragments of which have been preserved in the works of other writers. In one of these fragments we find mention made of a tribe of *Guttones* bordering upon the Germans, and who lived round a gulf of the sea called Mentonomon, a day's sail from the Island of Abalus, where they used to gather amber and sell it to the neighboring Teutones. This gulf, there is every reason to believe, was the *Frisches Haff*, situated on the Prussian shore of the Baltic. The next notice that occurs of the Goths is in the *Germania* of Tacitus, in which they are called *Gothones*, and are represented as dwelling beyond the Lygii; in the same direction, that is, as the one pointed out by Pytheas, though not on the sea-coast. Tacitus also distinguishes them from the Gothini, a tribe east of the Quadi and Marcomanni, and who are represented by him as using the Gallican tongue. The Gothones, according to this historian, were under regal government, and on that account not quite so free as the other tribes of Germany, but still they enjoyed a considerable amount of liberty. The tribes next beyond them, and dwelling immediately on the sea-coast, were the Rugii and Lemovii, whose form of government was also monarchical, and their weapons, like those of the Gothones, round shields and short swords.

GOUDRONS.—Small fascines, or fagots, which are well steeped in wax, pitch, and glue, and then are lighted for the pupose of setting fire to beams, planks, traverses, galleries, pontons, etc. They are likewise used in various shapes and ways to convey light into the ditches or upon the ramparts.

GOUR.—An article of forage fed to elephants in India. It consists of wheaten cakes mixed with molasses, and the daily ration is from 15 to 30 pounds, according to the size of the animal.

GOURDIN.—A flat stick, two or three fingers in breadth, which was used by the French to punish galley-slaves.

GOVERNMENT.—The Constitution of the United States provides that Congress shall make rules for the government and regulation of armies. By government is understood not only the body of fundamental laws of a State, but also the body of persons charged with the management of the executive power of a country, direction, power or authority which rules a community, administration, rule, management. Government of the military is that branch of the code which embraces the creation and regulation of the military *hierarchy*, or the gradual distribution of inferior authority. The power of making rules of government is that of Supreme Command, and from this living principle proceeds the localization of troops; their organization and distribution; rules for rewards and punishments; and generally all rules of government and *regulation* whatsoever which the legislature may judge necessary to maintain an efficient and well-disciplined army. All authority over the land forces of the United States must therefore be derived from Congress. For although the President is the Commander-in-Chief, yet his functions as such must be regulated by Congress, under the 17th clause of Section 8 of the Constitution, as well as under the general authority of Congress to make rules for the government and regulation of the land forces. The President cannot be divested of power which Congress may assign to any inferior Military Commander, because the authority of the greater includes that of the less. But all authority over the land and naval forces save the *appointment* of the Commander-in-Chief rests with Congress, and no authority can be exercised not delegated by Congress, except such as may be fairly deduced from powers given for the effective discharge of the duties annexed to his office.

GOVERNOR.—1. The officer placed by royal commission in the military command of any fortress, not only over the garrison but over the inhabitants. In time of war it is an office of great responsibility, and at all times requires considerable experience and military information. In the United States a Governor is invested with supreme authority in a State.

2. A device which regulates the admission of steam to the engine according to the rate of motion. The intention is to maintain uniform velocity, and any acceleration of speed above a given rate causes a valve to be partially closed, diminishing the area of steam-passage: contrariwise in case of flagging in the speed of motion of the engine. Fig. 1 shows a vertical section through the center of the governor and its parts, together with a cross-section of the girder of the Cummer engine; this section being along the center line of the governor-shaft shows the main eccentric, cast solid with it. The cut-off eccentric, with its sleeve, it will be observed, fits loosely on the governor-shaft, and is connected with the flying ends of the governor-weights by means of rods or links (as shown in Fig. 2) in such a manner that the cut-off eccentric, with its sleeve, is moved around the governor-shaft, either forward or backward, as the flying weights change their position; by this means the steam is cut off correspondingly earlier or later in the stroke as the governor or flying weights adjust themselves to the load.

The governor-shaft is driven from the main shaft by a train of gears, one of which appears in section in Fig. 1. The governor-case, to which is attached the flying weights, is keyed to the governor-shaft, and revolves with it. It will be noticed the governor-shaft is hollow, and has passing through it a thrust-rod. One end of this thrust-rod is attached to a cross-bar, which, passing through a slot in the governor-shaft, is thereby made to revolve with it. The cross-bar just referred to is connected with the governor or flying weights by suitable connections and bell-cranks shown in Fig. 1. The other end of the thrust-rod fits into a step which is jointed to the vertical arm of the large bell-crank shown in Fig. 1. It will be clear that any movement of the weights in the governor case would cause the thrust-rod to move correspondingly out or in, and thus operate or change the relative position of the large bell-crank and cause the weight located under the engine and attached to the end of the horizontal arm of the bell-crank to be raised or lowered in an amount corresponding to the outer or inner position of the governor-weights.

Referring once more to the cut-off eccentric, Fig. 2 shows how the flying ends of the governor-weights are connected by means of two rods and a clamp collar with the sleeve of the cut-off eccentric, so that, as the governor-weights change their position, the eccentric, with its sleeve, moves around the shaft either forward or backward. When the cut-off eccentric is rotated forward, the steam is cut off earlier in the stroke; when the eccentric is rotated backward, the steam is cut off later in the stroke. The extreme range of cut-off as controlled by this governor may be from 0 to 8–10 of the stroke measured from the beginning; these extremes correspond to the extreme positions of the flying weights, or, in other words, the engine is controlled by the governor from a simple friction-load to the full capacity of the engine. It will be seen that the dead weights suspended from the horizontal arm of the large bell-crank can be varied or adjusted in amount. This provision is made in order to regulate the speed of the engine. Whenever a change, either faster or slower than standard speed, is desired, the required variation is effected by simply adding to or taking from these loose weights under the bed; the change is easily made without the necessity for stopping the engine.

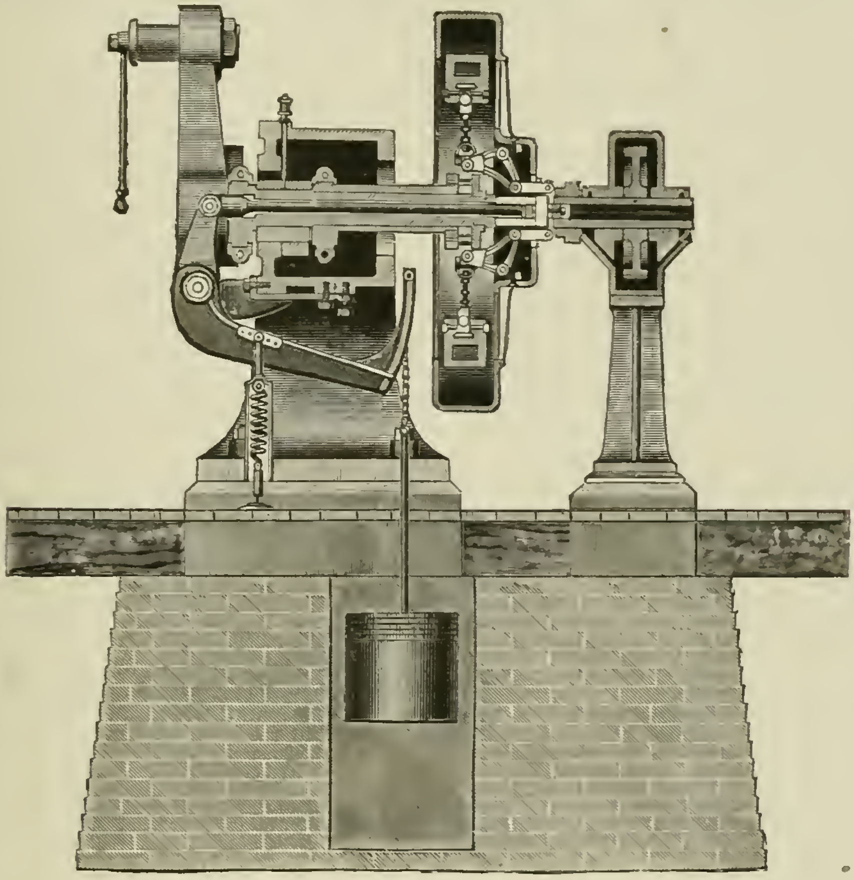


Fig. 1.

The object of the governor is to preserve a certain determined speed with the smallest possible variation from constant speed as changes in the load occur. The cut-off must always be proportioned to the load. When no load is on, steam is cut off very early in the stroke, and the flying weights are at their extreme outer position; with a heavy load steam follows further, and the weights are nearer their inner position. Between these two limits any number of positions of the weights and corresponding angular positions of the cut-off eccentric may be had, and in each position as the steam is adapted to the load, the slightest increase or decrease in speed must make a change in the cut-off and bring the engine again to standard speed. In order that the governor may be very sensitive and instantly feel any variation of speed, it is necessary that the centrifugal force of the flying weights and the opposing centripetal force exerted by the dead weights and spring on the large bell-crank be exactly balanced in every position they can possibly take; then any change of speed will cause the flying weights to instantly move in or out and be just as well balanced in their new position and as sensitive to any other variation in speed as they were before. This balancing of the centrifugal force, which is generated by the flying weights of the governor, is accomplished by the weights suspended from the horizontal arm of the large bell-crank and the spring attached to the same arm. The governor is adjusted for whatever speed may be desired.

The mechanism of the governor is such as to permit of a delicate adjustment. Referring to Fig. 1, it will be seen that the point of attachment of the spring

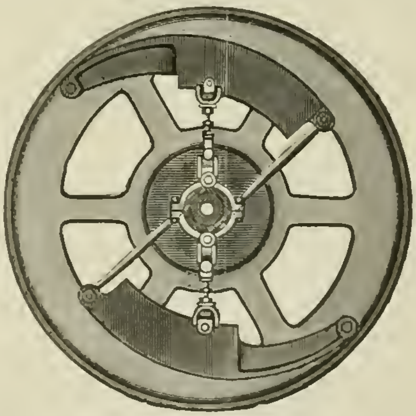


Fig. 2.

may be shifted so as to get more or less leverage and extension of the spring, and therefore more or less centripetal force. There is a series of holes on the arm for this purpose. The governor-weights and the tension of the spring are all calculated as closely as may be; then the final adjustment is made by attaching the spring at a greater or less distance from the fulcrum of the bell-crank, and thus the balance between the opposing forces may be exactly determined, and the adjustment so accurately made that these forces increase and decrease in the same ratio.

There is a point to be noted in connection with this spring; the dead weights furnish a constant centripetal force to balance the centrifugal force of the weights when at their inner position. All the spring has to do is to furnish what is necessary to balance the increase of centrifugal force as the weights move out from the center; the initial tension is 0; its duty is light, it is never severely strained, and it has periods of rest, so that its elasticity does not become impaired. In this respect this governor differs from all those in which a spring is required to furnish all the necessary centripetal force. It is quite obvious that such a spring has a more severe and very injurious duty to perform, because it is always under tension, so that its elasticity soon becomes impaired and the Governor does not act properly. A comparison of the two methods of construction will show clearly the superiority of this governor and explains the very close governing under varying loads for which the Cummer engine has achieved an excellent reputation.

The effectiveness and force of a governor-weight varies in the ratio of the squares of the velocities; and as the velocity depends upon the radius of gyration, it is easily seen why the weights should approach and recede from the center by only a small amount, and this is permitted by the small movement required to operate the eccentric; and it follows also that, when the weights are at their inner position, and the engine is following $\frac{3}{8}$ to $\frac{3}{4}$ of the stroke, the weights have moved inward so little, or from $\frac{1}{8}$ to $\frac{1}{4}$ of what would be necesary if the governor was placed on the main shaft, that the governor has the valves and the engine as much under control as when in any other position. It is important that the governor-weights be given such an adjusting movement that, when at their inner position, their force and value for governing shall not be impaired. From what has been said, it will be seen that the weights are always in an effective position and the governor acts equally well from 0 up to $\frac{3}{4}$ of the stroke. See *Steam engine*.

GOVERNOR-GENERAL OF INDIA.—The Chief Executive Officer of that Dependency, who has also the rank and position of a Viceroy. He is appointed by the Crown for a period of five years, which, however, can be extended. The Governor-General is subject in all matters of moment to the control of the Crown, through the Secretary of State for India. He is assisted by an Executive Council, composed of six members, should he see the necessity of so many, viz., two civilians, a law and financial member, a military member, and a member of public works. All acts of the Government are performed in the name of the Governor-General "in Council;" not that he is necessarily bound to the majority of his Council, as he can dissent altogether from their opinion, and act accordingly, if he thinks fit. The above members, with the addition of a civilian from Madras and Bombay, a few non-official members selected from the European commercial community, and one or two native noblemen, constitute the Supreme Legislative Council for making laws and regulations. But the Governor-General has the power of making rules and regulations, on an emergency, with reduced numbers of his Council.

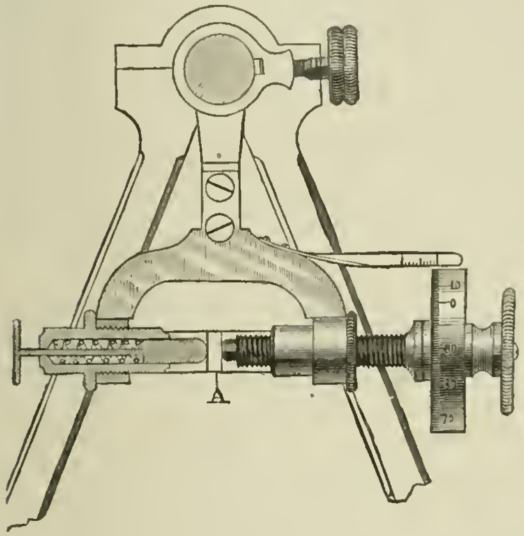
GOWRIE CONSPIRACY.—One of the most singular events in the history of Scotland, which took place in August, 1600. On the 5th of that month, as King James VI., then residing at Falkland Palace, in Fife, was going out to hunt, Alexander Ruthven, brother of the Earl of Gowrie, whose father had been executed for treason in 1584, came to his Majesty, and informed him that, on the previous evening, he had seized a person of a suspicious appearance, and evidently disguised, with a pot full of foreign gold hid under his cloak, and had confined him in his brother's house at Perth. Conceiving him to be an agent of the Pope or the King of Spain, the King agreed to examine the man himself, and without waiting to change his horse, set out for Perth, attended only by the Duke of Lennox, the Earl of Mar, and about twenty others. Soon after his arrival, while his retinue were at dinner, Ruthven conducted the King up a winding staircase and through several apartments, the doors of which he locked behind him, and brought him at last to a small study, where stood a man in armor, with a sword and dagger by his side. Snatching the dagger from the man's girdle, Ruthven held it to the King's breast, and said, "Who murdered my father? Is not thy conscience burdened by his innocent blood? Thou art now my prisoner, and must be content to follow our will, and to be used as we list. Seek not to escape; utter but a cry, make but a motion to open the window, and this dagger is in thy heart." The King expostulated with Ruthven, who so far relented that he went to consult his brother, leaving the King in charge of the man in armor. In the mean time, one of Gowrie's servants hastily entered the apartment where the King's retinue were, and announced that the King had just ridden off towards Falkland. All hurried into the street, and the Earl, with the utmost eagerness, called for their horses. On Alexander Ruthven's return to the King, he declared that there was now no remedy, but that he must die, and proceeded to bind his hands with a garter. The King grappled with him, and a fierce struggle ensued. Dragging Ruthven towards a window looking into the street, which the man in armor had opened, the King cried aloud for help. His attendants knew his voice, and hastened to his assistance. Lennox and Mar, with the greater number of the royal train, ran up the principal staircase, but found all the doors shut. Sir John Ramsay, of the Dalhousie family, one of the royal pages, ascending by a back stair, entered the study, the door of which was open, and seizing Ruthven, stabbed him twice with his dagger, and thrust him down the stair, where he was killed by Sir Thomas Erskine and Sir Hugh Herries. Upon the death of his brother, Gowrie rushed into the room, with a drawn sword in each hand, followed by seven retainers, well armed, and was instantly attacked. Pierced through the heart by Sir John Ramsay, he fell dead without uttering a word. The inhabitants of Perth, by whom Gowrie, who was their Provost, was much beloved, hearing of his fate, ran to arms, and, surrounding the house, threatened revenge. The King addressed them from a window, and admitted the Magistrates, to whom he fully related all the circumstances, on which they dispersed, and he returned to Falkland. Three of the Earl's servants were executed at Perth. The man in armor, Andrew Henderson, the Earl's steward, was pardoned. All who were examined were totally ignorant of the motives which prompted the brothers Ruthven to such a deed, and they still remain in some degree of mystery, although recent discoveries have led to a pretty general belief that the object of the conspirators was to possess themselves of the King's person, to convey him by water to Fast Castle, and either to give him up to England, or to administer the Government in his name in the interest of that country and of the Presbyterian leaders at home. Most of the documents relating to the plot are printed.

GRADE.—A term synonymous with rank, and peculiarly applicable to the different ranks among officers, beginning from an Ensign to the Commander-in-Chief of an army. See *Rank*.

GRADIENT.—In Heraldry, a tortoise when walking is said to be gradient. The term is used chiefly in connection with earthworks and roads to signify a departure of the line from a perfect level.

GRADIENTER.—An attachment often used with transits for fixing grades, determining distances, etc.

It is shown in the drawing, and consists mainly of a screw attached to the semicircular expanded arm of the ordinary clamp of the telescope axis; the screw is accurately cut to a given number of threads, and passing through a nut in one side of the arm, presses against a little stud, A, fixed to the inside surface of the right-hand standard. In the other side of the semicircular arm is inserted a hollow cylinder containing a pin actuated by a strong spiral spring, the end of the pin pressing against the side of the stud opposite that in contact with the screw. Near the other end of the screw, and turning with it, is a wheel, or micrometer, the rim of which is plated with silver, and divided into one hundred equal parts. A small silver scale, attached to the arm and just above the micrometer-wheel, is divided into spaces, each of which is just equal to one revolution of the screw; so that by comparing the edge of the wheel with the divisions of the scale, the number of complete revolutions of the screw can be easily counted. It will be seen that when the clamp is made fast to the axis by



Gradienter.

the clamp-screw, and the gradienter screw turned, it will move the telescope vertically, precisely like the tangent-screw ordinarily used. And as the value of a thread is such that a complete revolution of the screw will move the horizontal cross-wire of the telescope over a space of one foot on a rod at a distance of one hundred feet, it is clear that when the screw is turned through fifty spaces on the graduated head, the wire will pass over fifty one hundredths, or one half a foot on the rod, and so on in the same proportion. In this way the gradienter can be used in the measurement of distances, precisely like the micrometer already described in the article on the Engineer's Transit. Grades can also be established with great facility, as follows: First level the instrument; bring the telescope level to its center by the clamp and gradienter-screw; move the graduated head until its zero is brought to the edge of the scale; and then turn off as many spaces on the head as there are hundredths of feet to the hundred in the grade that is to be established. See *Micrometer*.

GRADIVUS.—The Roman Mars, who as a war-god was surnamed *Gradivus* (= *grandis divus*, the great god), also bore the surname of *Silvanus*, and appears to have been originally an agricultural deity; and propitiatory offerings were presented to him as the guardian of fields and flocks; but as the fierce shepherds who founded the city of Rome were even more addicted to martial than to pastoral pursuits, one can easily understand how *M. Silvanus* should have, in the course of time, become the "God of War." See *Mars*.

GRADUATION.—The art of dividing mathematical, astronomical, and other instruments. The simplest problem in graduation is the dividing of the straight line, such as an ordinary scale or rule. This is commonly done by copying from a standard scale, for which purpose a dividing square and a suitable knife for cutting the divisions are used. The dividing square is a hard steel straight-edge, with a shoulder at right angles like a carpenter's square. This is made to slide along the standard scale, and halt at each required division, when a corresponding one is cut upon the rule, etc., by using the steel straight-edge as a guide to the knife. The *original graduation* of a straight line into equal divisions, as in making a first standard scale, etc., is performed either on the principle of *bisection* or *stepping*. In bisecting, the points of a beam-compass are adjusted to nearly half the length of the line to be divided; one point is then placed at one end of the line, and a faint arc struck towards the middle: this is repeated at the other end; the small distance between these arcs is then carefully bisected with the aid of a fine pointer and magnifier, which gives an accurate half of the line. The half thus obtained is again bisected in like manner, and these quarters bisected again, and so on until the required subdivision is attained. Stepping is performed with delicately pointed spring-dividers, which are set at once as nearly as possible to the opening of the small division required; then the points are made to step on, leaving at each step a very fine dot; and when it is found that the last dot either falls short of or overpasses the end of the line, the opening is adjusted accordingly, until perfect accuracy is obtained. Thus, if a line were divided into a thousand parts, and each division were $\frac{1}{1000}$ too long or too short, the error would amount to a whole division at the end of a thousand steps. The method of bisection is practically the most accurate, and has been adopted by Graham, Bird, Ramsden, Troughton, and all other eminent artists in original graduation. Curved lines are divided on this principle. The chord of an arc of 60° is equal to the radius; therefore the opening of the compasses required for striking the circle gives this arc at once to start with. An arc of 90°, or a quadrant, is obtained by bisecting 60° and adding the half. By continual bisection of 60°, the finer graduations are produced. The amount of care, patience, skill, and delicacy of touch required in the original graduation of important astronomical instruments is such that not above one or two men in a generation have been found competent to the task, and these have become almost as famous as the astronomers who have successfully used the instruments. It would be out of place here to point out in detail the minute precautions and methods of correction that are adopted in this most delicate manipulation; but, as one example, we may mention the fact that Graham, when dividing the mural quadrant for the Greenwich observatory, measured his larger chords from a scale made for the purpose; but before laying these down on the quadrant, he left the scale, beam-compasses, and quadrant to stand for a whole night, in order to acquire exactly the same temperature, and that neglect of this precaution would have involved a notable amount of error. The necessity of such extreme accuracy will be understood when we consider the application that is made of these divisions. When, for example, the mariner determines his latitude by taking the meridian altitude of the sun, the graduated arc of the limb of the sextant or quadrant he uses represents, practically, the curved surface of the globe, and the error is magnified just to the same extent as the radius of the earth exceeds that of the divided arc of the instrument. Supposing this arc to be part of a circle of 60 inches circumference, each degree will occupy $\frac{1}{6}$ of an inch. An error of $\frac{1}{100}$ of an inch in the division would thus mislead the mariner to an extent of more than four statute miles as regards his position on the waters. But such a ship's quadrant is but a coarse and rude instrument compared with astronomical instruments for measuring celestial angular distances by means of a divided arc; in these an error of a thousandth part of an inch would be regarded as one of very serious magnitude. See *Dividing-engine*.

GRADUATION OF REAR SIGHTS.—The rear sights of small-arms are graduated with elevation-marks for certain distances, generally every hundred yards; in aiming with these, as with all other arms, it is first necessary to know the distance of the object. This being known, and the slider being placed opposite the mark corresponding to this distance, the bottom of the rear-sight notch and the top of the front sight are brought into a line joining the object and the eye of the marksman. The term *coarse sight* is used when a considerable portion of the front sight is seen above the bottom of the rear-sight notch; and the term *fine sight*, when but a small portion of it is seen. The graduation-marks being determined for a fine sight, the effect of a coarse sight is to increase the true range of the projectile. If the form of the trajectory be known, the rear sight of a fire-arm can be graduated by calculation; the more accurate and reliable method, however, is by trial. Suppose it be required to mark the graduation for 100 yards; the slider is placed as near the position of the required mark as the judgment of the experimenter may indicate; and, with this elevation, the piece is carefully aimed, and fired, say, ten times at a target placed on level ground, at a distance of 100 yards. If the assumed position of the slider be correct, the center of impact of the ten shot-holes will coincide with the point aimed at; if it be incorrect, or the center of impact be found below the point aimed at, then the position of the slider is too low on the scale. Let P be the point aimed at, and P' the center of impact of

the cluster of shot-holes; we have, from close similarity of the triangles, $A'F : FP :: AA'' : PP'$, from which we can determine $A'A''$, the quantity that must be added to AA' to give the correct position of the graduation-mark for 100 yards. If the center of impact had been above P, the trial-mark would have been too high. Lay off the distance AA'' above A'', on the scale, and we obtain an approximate graduation for 200 yards, which should be corrected in the same way as the preceding, and so on. The distance PP' is found by taking the algebraic sum of the distances of all the shots from the point P, and dividing it by the number of shots. It will be readily seen that an approximate form of the trajectory may be obtained by drawing a series of lines through the different graduation-marks of the rear sight, and the top of the front sight, and laying off from the front sight, on each line, the corresponding range. The points thus determined are situated in the required trajectory. See *Sight*.

GRAINOIR.—A term used in the French artillery to signify a sort of sieve, in which there are small round holes for moist powder to be passed through, in order to make the grains perfectly round.

GRAINS D'ORGE.—A coat of mail in riveted rings. It is entirely formed of metal rings, and has neither wrong side nor lining.

GRAND DIVISION.—A battalion or regiment being told off by two companies to each division is said to be told off in grand divisions; hence grand-division firing is when the battalion fires by two companies at the same time, and is commanded by one officer only.

GRAND GUARD-MOUNTING.—The grand guard-mounting is conducted upon the same principle as the regimental guard-mounting. Each regimental detachment is assembled on its parade and verified by the Adjutant, after which it is marched to the general parade by the senior officer or non-commissioned officer of the detachment. The officer of each detachment, having formed it in open order, places himself two yards in front of its center, the guides taking their places in the line of file-closers as the detachment is halted. A Staff-officer counts the files, verifies the details by reference to written orders, causes the guard to count fours, divides it into two or more platoons, and then dresses it to the right. A space for the guide is left between the platoons, which is temporarily occupied by a file closer, and through which the file-closers pass at the command: 1. *Officers and non commissioned officers to the front and center*, 2. MARCH. Each platoon is inspected by its Chief. The guard having passed in review before the Field Officer of the Day is formed to the left into line, and halted by the Staff-officer. The Field Officer of the Day then sends the guard by detachments to the various posts. See *Guard-mounting*.

GRAND GUARDS.—The main guards covering an army or camp from an attack by the enemy. Inasmuch as the grand guards furnish the outposts, and serve as their supports, not more than one third of their force should be taken for the outposts. The grand guards are posted on the principal avenues leading to the detachments on which they are to fall back, if driven in; and, when of infantry, about 200 paces, and of cavalry, 600 to 800 paces, in the rear of the outposts. The points which they occupy should be selected both to secure them from the enemy's view and to give a ready communication between them and their respective outposts. No difficult or broken ground should lie between the grand guards and their outposts; if any such occur, particularly if it be of a nature to offer facilities to an enemy to penetrate to the rear, the whole should be posted on the farther or hither side; and in preference in the latter position, if by it the chain of posts can be kept unbroken. Grand guards are chiefly to watch the enemy in front; their flanks are protected by each other, and the camp must furnish posts to protect their rear and secure retreat. In broken or mountainous countries, particularly if the inhabitants are ill-disposed, intermediate posts must be established when it is necessary to post the grand guards at a distance from the camp. The General of Division, if he thinks proper, changes the stations and orders of these guards, and establishes posts to connect the brigades or protect the exterior flanks.

The following are the standing instructions to grand guards, beside the special orders given in each case: To inform the nearest posts and the Field Officer of the Day, or the General of Brigade, of the movements of the enemy, and of the attacks they receive or apprehend; to examine every person passing near the post, particularly those coming from without; to arrest suspicious persons, and all soldiers and camp-followers who try to pass out without permission, and to send to the General, unless otherwise directed, all country people who come in. Deserters are disarmed at the advanced-posts, and sent to the Commander of the grand guard, who gets from them all the information he can. If many come at night, they are received *cautiously, a few at a time.* They are sent in the morning to the Field Officer of the Day, or to the nearest post or camp, to be conducted to the General of the Brigade. All suspected persons are searched by the Commanders of the posts. Grand guards are often charged with the care and working of telegraphic signals. The Commandants of grand guards visit the sentinels often; change their positions when necessary; make them repeat their orders; teach them under what circumstances and at what signals to retire, and particularly not to fall back directly on their guard if pursued, but to lead the enemy in a circuit. The fires of grand guards should be hidden by some sort of screen. To deceive the enemy, fires are sometimes made on ground not occupied. Fires are not permitted at small posts liable to surprise.

GRAND-MASTER.—The title of the Head of the Military Orders, the Hospitallers, the Templars, and the Teutonic Knights; see these articles. The title originally borne by the Superior of the Hospitallers was simply "Master" (*Magister*); but in 1268 Hugh de Reval took that by which they are since known—Grand-Master, *Magnus-Magister*. In the Teutonic Order, the title "Master," with different modifications, was applied to the several Superiors of the Order in the various countries. Thus, the Superior of Germany was styled *Teutsch-Meister*, "German Master." The Superior of Livonia was called *Heer-Meister*, "Military Master." In all these Orders the office of Grand-Master was held for life. The name was also used in the Dominican Order.

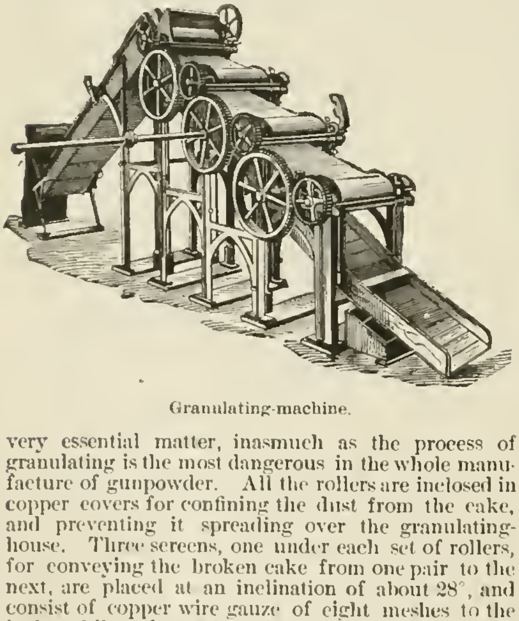
GRAND-MASTER OF CROSS-BOWS.—The *personnel* of the French artillery was for a long time prior to 1420 retained, together with the engineers, under the general direction of an officer who was titled *Grand-Master of Cross-bows*. In 1420 the Master-General of Artillery was made independent of this officer.

GRAND ROUNDS.—Every General Officer, or the Commander of a Post or Garrison, may visit the guards of his command, and go the Grand Rounds, and be received in the same manner as prescribed for the Officer of the Day. The Officer of the Day, wishing to make the Rounds, takes an escort of one non-commissioned officer and two men. Whenever the Rounds are challenged by a sentinel, the Sergeant answers, "Grand Rounds!" and the sentinel replies, "Halt, Grand Rounds! Advance, Sergeant, with the countersign!" Upon which the Sergeant advances and gives the countersign. The sentinel then cries, "Advance, Rounds!" and stands at a carry till they have passed. When the sentinel before the guard challenges, and is answered, "Grand Rounds!" he replies, "Halt, Grand Rounds! Turn out the guard; Grand Rounds!" Upon which the guard is drawn up with arms at a carry. The Officer Commanding the Guard then orders a Sergeant and two men to advance; when within ten paces, the Sergeant challenges. The Sergeant of the Grand Rounds answers, "Grand Rounds!" The Sergeant of the Guard replies, "Advance, Sergeant with the countersign!" The Sergeant of the Rounds advances alone, gives the countersign, and returns to his Round. The Sergeant of the Guard calls to his officer, "The countersign is right!" on which the Officer of the Guard calls, "Advance, Rounds!" The guard being at a carry, the Officer of the Rounds advances alone to the Officer of the Guard, who keeps his post and gives to him the parole. He then examines the guard, orders back his escort, and, taking another one, proceeds in the same manner to other guards. All material instructions given to a sentinel on post by persons entitled to make Grand Rounds are promptly and fully reported to the Commander of the Guard. See *Rounds*.

GRAND SERJEANTY.—The most honorable of all the ancient feudal tenures. According to Lyttleton, tenure by Grand Serjeanty is where a man holds his lands or tenements of the Sovereign Lord the King by such services as he ought to do in his proper person to the King, as to carry his banner or his lance, or to lead his army, or to be his Marshal, or to carry his sword before him at his coronation, or his Carver, or his Butler, or to be one of his Chamberlains of the receipt of his Exchequer, or to do other like services. This tenure must have been held of the King. Where lands were held of a subject, on condition of performance of services identical with those which were rendered to the King, the tenure was not Grand Serjeanty, but Knight's Service. Thus, lands on the Scottish border held of the King by cornage—i.e., on condition of winding a horn to give notice when the Scots had crossed the border—were held in Grand Serjeanty; but lands held of a subject for the same service were held in Knight's Service. Tenants holding by Grand Serjeanty were free from escuage, which usually appertained to Knight's Service, and in general could only be called upon to perform their services *infra quatuor maria*, within the Kingdom. The services in Grand Serjeanty were to be performed by the tenant in person, where he was able to do so. The office of attendance on the Sovereign's person was esteemed so honorable that no one below the dignity of a Knight could perform it. Hence, where lands held by Grand Serjeanty were in the possession of a citizen, he was permitted to perform his service by Deputy. This tenure by Grand Serjeanty was, in common with other military tenures, reduced to common Socage, except so far as regards the honorary services, which continue to be observed to this day. Thus, the Duke of Wellington holds of the Crown his estate of Strathfieldsaye on condition of presenting to the Sovereign a flag bearing the national colors on each succeeding anniversary of the Battle of Waterloo. The manor of Woodstock, with the demesne, in which is situated Blenheim Park, is held by the Duke of Marlborough by Grand Serjeanty, on condition of presenting to the Queen and her heirs, at the Castle of Windsor, a standard of France on the 13th of August yearly, being the anniversary of the day on which the Battle of Hochstädt was fought, near the village of Blenheim, on the banks of the Danube. The tenure of Grand Serjeanty was observed throughout the Continent of Europe. "The free-born Franks," says Mr. Hallam, *Middle Ages*, "saw nothing menial in the titles of Cupbearer, Steward, Marshal, or Master of the Horse, which are still borne by the noblest families in every country in Europe, and by Sovereign Princes in the Empire. The Count of Anjou, under Louis VI., claimed the office of Great Seneschal of France—i.e., to carry dishes to the King's table on state-days. Thus the feudal notions of Grand Serjeanty prepared the way for the restoration of royal supremacy, as the military tenures had impaired it." In Scotland, Grand Serjeanty was not known as a separate tenure—that is to say, lands held on condition of honorary services rendered to the Sovereign were not attended with any privileges other than those attaching to lands held in a similar manner of a subject superior. In that country a tenure by honorary service was known as a Blanch Holding.

GRAND TACTICS.—Tactics, or that branch of the art of war which treats of the methods of drawing up and moving troops systematically, has two modifications. 1. *Minor* or drill tactics, which embraces that setting up and preliminary drilling of soldiers essential to discipline, expertness in handling their weapons, and facility of movement preparatory to their employment on the field of battle. 2. *Grand* tactics, or the art of combining, disposing, and handling the troops on the field of battle. It is this latter branch of tactics that supplements strategy. In case the principles of both branches cannot be carried out at the same time, it is recommended to adhere to the rules of *Strategy* at the expense of *Tactics*, for some means may generally be found to modify bad tactical dispositions; as a change in the formation of the troops, the use of intrenchments, etc. See *Strategy* and *Tactics*.

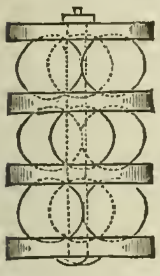
GRANULATING-MACHINE.—The machine used for granulating or reducing the pressed cake into grain-powder is somewhat similar in construction to the breaking-down machine; it is, however, fitted with four pairs of cutting rollers, and rectangular screens below the three upper pairs; these screens convey any grain not properly reduced by the one set of rollers to the next under them. The machine is composed of two side frames of gun-metal, which carry the rollers, screens, and all the other moving parts. The rollers are placed in pairs at an inclination of about 33°, and have a vertical height of 2 feet 5 inches between each pair; they are 7 inches in diameter, and make from twenty-five to thirty revolutions per minute, thus giving a speed of about 48 feet per minute to their toothed surfaces, the length of which for operating upon the powder is 2 feet 6 inches. The press-cake is fed to the machine by an endless band at the rate of about 30 lbs. per minute. The teeth in the several pairs of rollers vary in size and form. Those on the upper rollers are diamond-shaped, and resemble a series of small pyramids standing out from the surface of the rollers; these teeth are a quarter of an inch apart and the same in depth, and so arranged that those in the one roller work into the spaces of the other. The second pair of rollers have smaller teeth, but of the same form as the upper pair; they are a quarter of an inch apart, but only one eighth of an inch in depth. The teeth of the third and fourth pairs are differently shaped; in these they are formed by cutting V-shaped ribs longitudinally along the rollers and the rectangular grooves a quarter of an inch apart by one eighth of an inch in depth round their circumferences. The ribs of the one roller work into the grooves of the other, and *vice versa*, and their top and bottom edges are slightly rounded. On the side bearings, and behind each roller, there is fixed a scraper, the edge of which is provided with teeth corresponding with the grooves in the rollers, so that as the latter revolve, any powder adhering to them is cleared out, and this prevents their ever becoming clogged. The back roller of each pair is provided with a sliding bearing and is pressed forward towards the front rollers by weighted levers; this arrangement admits of their opening when necessary, and permits a glut of cake or any hard material to pass them with safety. This is a



Granulating-machine.

very essential matter, inasmuch as the process of granulating is the most dangerous in the whole manufacture of gunpowder. All the rollers are inclosed in copper covers for confining the dust from the cake, and preventing it spreading over the granulating-house. Three screens, one under each set of rollers, for conveying the broken cake from one pair to the next, are placed at an inclination of about 28°, and consist of copper wire gauze of eight meshes to the inch; while underneath, and embracing all the rollers, are three tiers of light separating-screens, contained within a deep frame set at an angle of 32°. The upper screen is of copper wire gauze of eight meshes to the inch; the second is likewise of copper wire gauze, but of sixteen meshes to the inch; while the third is a very fine (nearly close) screen, and receives the dust from the upper ones and conveys it into a box placed for the purpose. The separating-screen frame is slung from the gun-metal framing of the machine by light springs made of lancewood. The screens themselves are also carried from the frame by the same means, and the whole has a longitudinal movement given to it of 182 vibrations per minute, produced by polygonal wheels on the driving-shaft, which press against circular but loose-running wheels attached to the separating-screen frame. The surfaces of these wheels are kept in contact by the weight of the screen itself. The process of granulating the press-cake may be described as follows: The cake, having been broken into pieces, is put into a wooden hopper, which holds 700 pounds; the side of this hopper next the inclined frame is open to a shoot, and the hopper itself—when the machine is at work—moves slowly up this inclined frame, the speed being regulated so as to suit that of an endless feed-band made of canvas, with strips of leather sewn across it. A rope, set in motion by one of the machine-shafts in connection with a worm and wheel, is used to raise the hopper, the cake in which, falling through the shoot on to the endless band, is carried forward to the uppermost or first pair of rollers. From these it is conducted to each successive pair by the screens, and these, having a quick vibrating motion, allow any grain that has been broken small enough to pass through them into the upper long separating-screen in the frame underneath. Such grain as is too large to go through any of the screens is called "chucks," and is collected and passed through the machine a second time. The grain which passes the upper, or eight-mesh long screen, is used for common powder; that which passes through the sixteen-mesh long screen is suitable for rifle or small-arm powder; and that which passes through into the lower screen is dust. The powder as it falls from the surface of the different screens is collected in separate boxes placed underneath the machine for its reception. When the hopper has reached the limit of its travel upwards, and all the cake has passed on to the feeding-band, which it will do in from twenty-five to thirty minutes after the machine has been set in motion, the hopper acts, by a self-acting arrangement on a clutch, which throws the rope-wheel out of gear, and thus stops the further travel of the hopper, while a counter-balance weight prevents its descent. At the same time that the clutch throws the wheel out of gear, it relieves a catch connected with a wire spring and bell; the latter, by ringing in the bomb-proof house, wherein the workmen remain while the machine is in operation, gives them notice that the hopper is empty. After allowing about five minutes for the band and machine to become quite empty, the apparatus is stopped, and the attendants, now leaving their place of safety, enter the granulating-house, and empty the grain from the several boxes into tubs for removal. No one is on any account permitted to enter the granulating house whilst the machine is working, and as a further precautionary measure the attendants or others who have occasion to enter the house at other times wear sewn hide-leather boots. After all the powder is removed, the hopper is let down to its proper place and refilled with cake, and the machine is now again ready for use; the attendants therefore leave the granulating-house and retire to the bomb-proof building, where they set the machine in motion, and remain under cover until the bell again rings, when, after allowing a few minutes to elapse, they stop the machine, both the starting and the stopping being effected in the bomb-proof house. When a fine-grain powder is required, rollers with smaller teeth are used, together with screens of 24 and 32 meshes to the inch. The dust produced by this machine, as well as from all the other machines, is collected and taken back to the incorporating-mill, where 50 pounds of it are spread out on the bed, and after being well damped it is worked under the edge runners for about one hour; it is then fit to be sent forward to the breaking-down machine, the press, and other subsequent operations. The quantity of dust produced varies considerably, according to the condition of the teeth of the granulating rollers; if they are much worn, or become foul, as they are apt to do during damp weather, the quantity of dust will be considerably increased; or if only fine-grain powder is being made, the percentage of dust will be great. As in the case of the breaking-down machine, so with the granulating-machine, no iron or steel is exposed, and indeed there is very little of either used in its construction, the shafts and bed-plate being the only parts made of those metals; the former, as well as the whole floor of the granulating-house, is covered with soft leather hide, and the shafts are all encased in copper or gun-metal. The side frames, rollers, wheels, bolts, nuts, and all other parts of the machine are made of gun-metal, copper, or wood. A machine of the size described is capable of granulating from 130 to 140 barrels of gunpowder in a day of twelve hours, supposing each barrel to contain 100 pounds. See *Gunpowder*.

GRAPE-SHOT.—The grape shot is composed of a number of small shot arranged around a spindle on an iron disk. Formerly the shot were inclosed in a canvas bag, which was drawn together between the balls, or "quilted" by a strong line; but the present method is more simple and durable. It consists of nine shot of a size appropriate to the caliber used, which are held together by two rings and a plate at each end of the stand, connected by a rod, as shown in the drawing. The diameter of balls for grape-shot varies with the caliber, being in all cases larger than those used for canister. Grape-shot are particularly valuable for use against torpedo-boats. See *Case-shot*, *Projectiles*, and *Siege and Garrison Ammunition*.



GRAPHITE.—A crystalline modification of carbon, very different in appearance and physical properties from the diamond. It is found in Cumberland, Siberia, Ceylon, Germany and France, and in North and South America. Graphite is a very good conductor of electricity; like the diamond it is unalterable by heat. It may be prepared artificially by bringing an excess of charcoal in contact with fused cast-iron; a portion of the carbon dissolves, and separates out again on cooling in large scales. It is used sometimes, amongst other purposes, in glazing gunpowder.

GRAPHOMETER.—A name sometimes, though inappropriately, given to the protractor, an instrument used in plotting surveys. It is a semicircle, marked with 180°, and, in the large instruments, with parts of degrees. Its use is to lay off angles. See *Protractor*.

GRAPNEL.—A small anchor of several flukes, used in mooring boats or pontons for military bridges. A grapnel having five prongs is also used for escalading purposes, to aid the assailants in effecting an entry into the place. When it is thus used, it is thrown over any spot where it is likely to anchor itself. A 2-inch rope, 60 feet in length, is attached to the shank.

GRASP.—The handle of a sword, also of an oar. Also, the small part of the stock of a musket.

GRAS RIFLE.—The Chassepôt rifle, modified by Major Gras, and now the arm definitively adopted by the French army. The barrel of the Chassepôt has been retained in the conversion, keeping the same caliber of .433 inch, with four grooves from right to left, with one turn in 21½ inches. But in the new barrel the depth of the grooves is slightly diminished, and the ledges rounded off. The same caliber has been retained in order that the same cartridge may be used in all arms. A metallic cartridge has been adopted, in lieu of the "self-consuming" one used for the Chassepôt; the bullet is of compressed lead, consequently the densest and most homogeneous. Its diameter at the base is .429 inch, instead of .468 inch, in order to reduce, within the smallest limits, the enormous friction the bullet undergoes in the barrel, which considerably diminishes the initial velocity. Thus the bullet of the Gras rifle, being smaller than the bore, is forced by depression, whilst in the Chassepôt it is forced longitudinally. This diminution of friction, combined with the removal of the "chambre ardente," or space behind the cartridge in the old rifle, has produced this effect, and the initial velocity, which was 1365 feet in the Chassepôt, has attained 1491 feet in the new arm. The length of the bullet is 1.092 inch, instead of .995 inch as formerly; that is, two and a half calibers. A greased wad is placed between the powder and the bullet. The bullet is covered with a strip of paper, in order to prevent *leading*; that is, deposits of lead in the grooves, which are fatal to accuracy. The barrel of this converted weapon has been modified in such a manner as to enable it to receive the new cartridge: 1st, by an alteration in its caliber; 2d, by the removal of the *tête mobile*, or movable head, in the breech mechanism, and by a modification of the cylinder, whereby the cartridge fits in closely; and, lastly, by the substitution of a striker or piston for the needle, and by the addition of a stronger spring and a cartridge-extractor. The breech action remains, as before, on the bolt principle. The conversion of the Chassepôt to the Gras rifle is computed to cost ten francs apiece.

GRASS-CUTTERS.—Natives of India attached to the artillery and cavalry branches of the service in that country, whose sole duty is to collect and bring in grass daily for the horses of their regiment. There is one to each horse or one to every two horses; the latter is called a *jorawallah*, and receives the pay of two men, but under these circumstances he has to keep a pony, and bring in grass equal to the load of two men. The grass-cutter's pay is from 8s. to 10s. a month.

GRASSIN.—A very early name for all militia composed of light troops. Now obsolete.

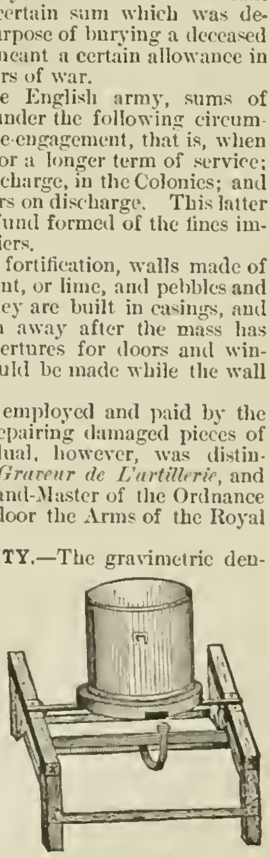
GRATIFICATION.—In a general acceptation of the term, this word meant, among the French, certain rewards which Generals gave to the troops, after a severe engagement, in testimony of their valor and good conduct. These rewards were distributed according to rank. By *gratification* was likewise meant the accumulation of a certain sum which was deposited for the specific purpose of burying a deceased soldier. The term also meant a certain allowance in money allotted to prisoners of war.

GRATUITIES.—In the English army, sums of money given to soldiers under the following circumstances: To soldiers on re-engagement, that is, when they engage to serve on for a longer term of service; to soldiers settling, on discharge, in the Colonies; and to all good-conduct soldiers on discharge. This latter gratuity is taken from a fund formed of the fines imposed upon drunken soldiers.

GRAVEL WALLS.—In fortification, walls made of a conglomeration of cement, or lime, and pebbles and small stones or slag. They are built in casings, and the planks may be taken away after the mass has properly hardened. Apertures for doors and windows, or embrasures, should be made while the wall is in process of building.

GRAVEURS.—Persons employed and paid by the founders of cannon for repairing damaged pieces of artillery. Some individual, however, was distinguished by the name of *Graveur de L'artillerie*, and was permitted by the Grand-Master of the Ordnance to exhibit over his shop-door the Arms of the Royal Artillery.

GRAVIMETRIC DENSITY.—The gravimetric density of a powder is the weight of a cubic foot of the powder expressed in ounces. It should fall between 875 and 900 ounces. This cannot be relied upon for the true density, as the shape of the grain may make the denser powder seem the lighter. It is only of value as giving a tolerably correct idea of the volume of the air-space in a given weight. The *gravimeter*, shown in the drawing, is weighed when filled loosely, and again when filled by packing the



Gravimeter.

powder. The powder, as it is poured in, is allowed to adjust itself naturally, without any packing. The settled weight is obtained by packing the powder through the process of rocking, shaking, turning, and jarring the gravimeter on a cradle, shown in the figure, and adding gradually to the contents, as a space is made by the packing together of the grains. In either case, when weighed, the gravimeter must be level full. This is shown by placing a pane of plate-glass over its top, and noticing whether it touches the rim of the gravimeter all around, and also if the powder is up to the surface of the glass all the way across. The only value attached to the use of a gravimeter is that of obtaining a tolerably correct idea of the volume of the air-space in any given weight. The air-space is dependent on the shape and size of the granules, and on the amount of settling or shaking together to which the powder is subjected. Knowing the specific gravity of the powder under examination, the air-space is found as follows: If w = the weight in ounces of 1 cubic foot of homogeneous powder, or the specific gravity multiplied by 1000, and w' = the weight in ounces of 1 cubic foot of same powder granulated, or the ascertained gravimetric density; then $\frac{w'}{w}$ = P is the proportion or per cent of the cubic foot occupied by the powder, and 1 — P = p is the proportion or per cent of the cubic foot occupied by air. These percentages are determined for the powder, both loose and settled. See *Inspection of Powder.*

GRAVITY.—Projectiles and all other bodies, when raised into the air and left unsupported, fall to the earth in lines perpendicular to it. The force which causes them to do so is termed gravity, and acts towards the earth's center; more strictly, it acts perpendicularly to the surface of still water. But if a projectile be projected obliquely into the air, it is made to describe a curved path, having a highest point, vertex, or apogee; and when it meets the earth in its descent, its direction is not towards the center, but inclined to it at the angle of projection. Observing this, and that the body, if not interrupted by the earth's surface, would continue to move in a curve, with its tangent always away from the center, it is easy to imagine that if not interrupted it might circulate round the center as the moon does round the earth. Next, knowing that the force of gravity is exerted at all accessible heights above the earth, the question arises—May it not be exerted as far off as the moon, which we know to be influenced by *some* force which continually deflects her from the tangent to her orbit, and makes her circulate round the earth? Observing now the time of revolution of the moon, and calculating its centrifugal force, which we know must equal the centripetal force, we put the question, Is this force the same as gravity? The answer is that it is a force 3600 times less energetic. If, then, gravity be the force which really holds the moon to her path, it must be explained why it acts upon her so much more feebly than it would were she a body on the earth's surface. The explanation is given at once if we suppose gravity to be a force whose energy diminishes with increase of distance, and is inversely as the squares of the distances at which it is exerted; for the distance of the moon from the earth's center is just about 60 times that of the earth's surface from its center, and 3600 : 1 : : 60^2 : 1. We infer that it does so from the fact that there is nothing inadmissible in such a diminution of energy with increase of distance—that, on the contrary, there are many analogies for it, as in the emanations of light and heat; and in the argument drawn from the necessity of otherwise supposing some other force than gravity to be employed in deflecting the moon, and the force of gravity to cease at some unknown level. On these views, and a generalization to be afterwards mentioned, Newton is understood to have at first rested his law of universal gravitation: "Every particle of matter in the universe attracts every other particle with a force directly proportioned to the mass of the attracting particle, and inversely to the square of the distance between them"—a law the truth of which, since it was first broached, has been put beyond all question by the most complete body of predictions, fulfilled to the letter, that can be cited in support of any law of nature.

Before, however, the argument on the extension of terrestrial gravity to the sphere of the moon could have become pregnant with so great a result, much investigation had to take place in other fields; and, in fact, Newton had, previously to conceiving the law, explained the three great Keplerian laws of order obtaining in the solar system by reference to an attractive force residing in the sun. These laws are—1. That the planets revolve round the sun in ellipses, having the sun for a common focus; 2. That every planet moves in such a way that the line drawn from it to the sun sweeps over equal areas in equal times; 3. That the squares of the times occupied by the several planets in their revolutions in their elliptic orbits are proportional to the cubes of their mean distances from their common focus, the sun. From the law of equal areas, Newton inferred that every planet is retained in its orbit by a force of attraction directed towards the center of the sun; from the orbits being elliptical, he inferred that in each case this force varies in intensity according to the inverse square of the body's distance from the sun; while from the third law he inferred the homogeneity of the central force throughout the solar system. It was then, after being familiar with the notion of terrestrial gravity and its action, through the researches of Galileo, Huyghens, and Hooke, and with the notion of a central force acting inversely as the square of the distance of its object, through his explanations of the laws of Kepler, that he put to himself the question,—Is not the force with which the moon gravitates to the earth the same with gravity?—the force which causes a stone to fall on its surface. A question answered affirmatively on the supposition of gravity, like the sun's attraction, being a force diminishing with increase of distance, and according to the same law. The result was to bring the whole solar system, the planets and the sun, and satellites and their planets—the satellites being observed to obey the same laws of order with reference to their primaries that the latter obeyed in reference to the sun—under the law of gravitation. And the imagination, lifted up by the grandeur of the conception, would refuse to limit the operation of that law to our own system, were there no facts to entitle us to extend it beyond. The phenomena of double stars, however, of themselves justify the extension and the statement of the law as we have given it in universal terms. It may be observed, in conclusion, that the Keplerian laws, which may be said to have been the basis of Newton's researches, are, owing to perturbations caused by the mutual action of the planets, etc., only approximately correct; and that these perturbations afford, when examined, a further proof of the truth and universality of the law of gravitation. See *Central Forces*, *Falling Bodies*, *Force*, and *Trajectory*.

GRAY CAST-IRON.—This variety of cast-iron is softer and less brittle than white iron; it is in a slight degree malleable and flexible, and is not sonorous; it can be easily drilled and turned in the lathe, and does not resist the file. It has a brilliant fracture, of a gray or sometimes a bluish-gray color; the color is lighter as the grain becomes closer, and its hardness increases at the same time. A medium-sized grain, bright gray color, lively aspect, fracture sharp to the touch, and close, compact texture indicate a good quality of iron. A grain either very large or very small, a dull, earthy aspect, loose texture, dissimilar crystals mixed together, indicate an inferior quality. Gray iron melts at a lower temperature than white iron, becomes more fluid, and preserves its fluidity longer; it runs smoothly; the color of the metal is red, and deeper in proportion as the heat is lower, it does not stick to the ladle; it fills the mould well; contracts less; and contains fewer cavities than white iron; the edges of a casting are sharp, and the surface smooth, convex, and covered with carburet of iron. Gray iron is the only kind suitable for making castings which require great strength, such as cannon. Its tenacity and specific gravity are *diminished* by slow cooling or annealing. See *Cast-iron.*

GRAZE.—The point at which a shot strikes and rebounds from earth or water. A *grazing-fire* is that which sweeps close to the surface it defends.

GRAZING RICOCHET.—The description of *ricochet* fire, when the *angle of fall* does not exceed 4°. In this fire the ball is given a great velocity, and the curve described is long and flat.

GREAT BRITAIN.—The Arms of the United Kingdom of Great Britain and of Ireland are borne by her Majesty Queen Victoria. Quarterly, first and fourth gules, three lions passant gardant in pale, or, for England; second, or, a lion rampant within a double tressure flory counterflory gules, for Scotland; third, azure, a harp or, stringed argent, for Ireland; all surrounded by the garter. *Crest.*—Upon the royal helmet, the imperial crown proper, thereon a lion statant gardant or, imperially crowned, also proper.

Royal Arms of Great Britain.

Supporters.—Dexter, the lion rampant gardant or, crowned as the crest. Sinister, a unicorn argent, armed crined, and unguled or, gorged with a coronet composed of crosses pattée and fleur-de-lis, a chain affixed thereto, passing between the fore legs, and reflexed over the back, also or. *Motto.—Dieu et mon Droit* in the compartment below the shield, with the union rose, shamrock, and thistle ingrafted on the same stem. Arms have been ascribed by heralds to the Saxon and Norman Monarchs of England in the tenth and eleventh centuries; but as Heraldry was, in point of fact, unknown till the middle of the twelfth century, they must be dealt with as fabulous. However, at a period almost before the earliest dawnings of hereditary coat-armor, the Sovereigns of England, in common with various other Monarchs of Christendom, adopted the lion as their device. Richard I., in his earliest seal, has two lions, which are borne counter-rampant; but in the latter part of his reign, after his return from the Third Crusade, the great seal of Cœur-de-lion represents the three lions in pale and passant gardant, as they have been almost uniformly depicted since. The only subsequent instance of which we are aware of any variation in the number is on a seal of the Carmelites at Oxford, in which Edward III. is represented in the surcoat charged with four lions in pale passant gardant, a proof of the latitude which heralds occasionally allowed themselves as late as the beginning of the fourteenth century. In 1340, Edward III., in virtue of the supposed right of his mother, assumed the title of King of France, and quartered the Arms of France with those of England, giving to the former the precedence. The fleurs-de-lis were then generally borne *sans nombre;* but in the latter part of the reign of Henry IV. they were reduced to three, borne or on a field azure. No further change took place in the royal escutcheon until the time of James I., except that Mary, on her second great seal, made after her marriage with Philip II., impaled the Arms of Spain and England. James VI. of Scotland, on succeeding to the throne of England, quartered the Arms borne by preceding Sovereigns with those of Scotland and Ireland, the first and fourth quarters being France and England quartered as before, the second quarter the lion rampant of Scotland within the double tressure, and the third quarter the harp of Ireland. The Royal Arms were similarly borne by all the Sovereigns of the House of Stuart till the reign of Anne, except that William III. bore over all the coat of Nassau on an escutcheon of pretense. In the reign of Anne, the legislative union with Scotland brought about a material change. England and Scotland impaled were placed in the first and fourth quarter, France in the second, and Ireland in the third. The accession of George I. displaced England and Scotland from the fourth quarter, to make way for the Arms of his Majesty's German dominions. A further alteration took place on the union with Ireland, when George III. laid aside the titular assumption of King of France, and abandoned the French ensigns. The Arms of England were now made to occupy the first and fourth quarter, Scotland the second, and Ireland the third, while the German ensigns were relegated to an escutcheon of pretense. These last were finally abandoned on the severance of Hanover from the Crown of Great Britain, which took place on the accession of Queen Victoria, and the royal escutcheon thus assumed its present arrangement.

From the union of the Crowns of England and Scotland under James I., up to the union of the Kingdoms in 1707, the Royal Arms were somewhat differently marshaled in Scotland, Scotland being allowed in all Scottish seals, ensigns, and Arms to occupy the first and fourth quarter, and England the second, while the whole were ensigned with the Crown of Scotland; but the Act of Union of 1707 recognizes no royal ensigns but those of the United Kingdom, which are to be "such as her Majesty shall think fit;" and on the union with Ireland, it was enacted that the armorial bearings of the United Kingdom "shall be such as his Majesty by his royal proclamation under the Great Seal of the United Kingdom shall be pleased to appoint." The practice, which prevails to a certain extent in Scotland, of giving the precedence to the Scottish lion in the royal shield, is incorrect, though the error has been committed in several of the official seals of the Kingdom.

The lion passant as the *crest* of England first appears on the Great Seal of Edward III.

The *supporters* borne in former times by the Kings of England varied much, particularly during the earlier period when these appendages of the shield were invested with more of a decorative than a heraldic character, and perhaps often left to the fancy of the engraver. When the Arms of any of the English Sovereigns from Richard II. to Edward IV. are represented with supporters, the animals selected are almost indifferently lions, antelopes, or white harts, and occasionally their place is supplied by angels. Edward IV.'s shield is sometimes supported on one side by a black bull, and Richard III.'s in one instance—in a MS. in the British Museum—on both sides by white boars. During the reigns of Henry VII. and Henry VIII., Edward VI., Mary and Elizabeth, the lion, red dragon, and greyhound were the supporters most in vogue, and as the herald or engraver had it not in his power to represent all three at once, he seems to have been allowed to select any two at pleasure. James I. for the first time clearly defined the royal supporters, adopting the lion of

England and unicorn of Scotland as they have ever since been borne, the unicorn having been, up to 1707, allowed precedence in Scotland. See *Arms*.

GREAT-COAT.—The overcoat issued to enlisted men. In the United States army it is of sky-blue cloth, double-breasted, or single-breasted with the additional cape; the linings and facings conforming to the trimmings of the uniform. On the frontier and campaign, officers may wear the soldier's great-coat with insignia of rank on the sleeve. See *Overcoat*.

GREAT CULVERIN.—A cannon of the French artillery, under Henry II., carrying a projectile weighing from 15 lbs. 2 ounces to 15 lbs. 4ounces.

GREAT FORTIFICATION.—One of the divisions of the first system of Vauban. It consists in a fortification whose exterior side is from 185 to 260 toises, or from 370 to 520 yards, and is seldom adopted but towards a river or a marsh.

GREAVES.—Pieces of armor formerly used as a defense for the legs (in the patois of Burgundy, *grève* still signifies "shin"). They were originally made of leather, quilted linen, etc., and afterwards of steel, hollowed out to fit the fronts of the legs, and fastened with straps behind. The Greeks termed them *knēmides* (whence the frequent expression in the *Iliad*, *euknēmides Achaioi*, or the "well-greaved Greeks"), and the Romans *ocreæ*.

GRECIAN ARMY.—Under a law promulgated in 1876, the military forces of Greece are divided into four parts—the Regular Army, the Regular Reserve, the Militia, and the Militia Reserve. All Greeks between 19 and 30 years of age, not serving in the Regular Army, are placed in the Regular Reserve; those from 31 to 40, in the Militia; and those from 41 to 50, in the Militia Reserve. The whole strength of the army under the bill is estimated at 200,000, 120,000 of whom belong to the Regular Army and its Reserve, 50,000 to the Militia, and 30,000 to the Militia Reserve. The number of the Regular Army is usually about 15,000. See *Army*.

GREEK BUCKLER.—This shield was distinguished by its two handles,—one in the center through which the arm passed, and one at the edge for the hand. In addition to this there was a leathern strap to hang the shield round the neck.

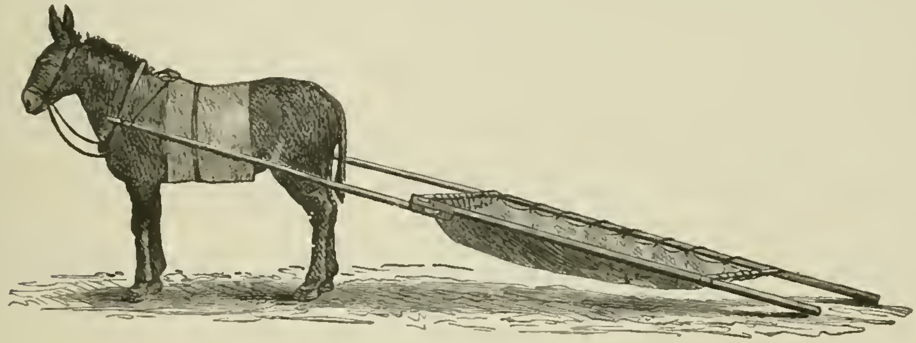
GREEK FIRE.—A composition supposed to have been of niter, sulphur, and naphtha as a principal ingredient, with which the Greeks of the Byzantine Empire were wont to defend themselves against their Saracen adversaries. The accounts of its effects are so mingled with obvious fable that it is difficult to arrive at any just conclusion as to its power; but the mixture appears to have been highly inflammable, and to have possessed the power of burning under water. It was projected either on blazing tow, tied to arrows, or through a tube, the precursor of cannon. Wherever the combustible fell, it made great havoc, from the inextinguishable nature of the fire. The invention of this material has usually been ascribed to Callinicus of Heliopolis, and the year 668 A.D.; but there seems to be reason to believe that it was rather imported from India. At Constantinople, the process of making Greek fire was kept a profound secret for several centuries. The knowledge, however, of its composition gradually spread; and at the time of the discovery of gunpowder, Greek fire formed a recognized defensive element in most wars from western Europe to Asia Minor. Subsisting for some time concurrently with gunpowder, it gradually died out before the advances of that still more effective competitor, till now little vestige remains of Greek fire beyond a Norman corruption of its name in our fire-work "Cracker," which, derived from "Creyke" of the Middle Ages, is but a corruption of "Grecque."

GREEN CHARGE.—In the manufacture of gunpowder certain processes have to be carried out, the primary one being that of "mixing the ingredients" after they have been weighed and brought into contact previous to being incorporated. The process of *mixing* is performed by putting the composition into a cylindrical gun-metal or copper drum, about 2 feet in diameter, with an axle passing through its center, on which there are metal flyers like forks; the machinery is so arranged that the flyers and drum revolve in opposite directions, at a rate of about 100 revolutions a minute; five minutes is long enough for a thorough mixture; the charge is then drawn off by a slip into a canvas bag capable of holding a 50-lb. charge, which is tightly tied and removed to a small magazine until required for the incorporating process. In this form it is called a *green charge*.

GREENE GUN.—A breech-loading rifle, having a fixed chamber closed by a movable breech-block which slides in the line of the barrel by direct action. This piece has a concealed spiral-spring lock. It is loaded through a mortise cut in the side of the receiver, and is locked by projections on the bolt engaging with corresponding cavities in the receiver. The handle of the breech-bolt is so formed as to lie close to the stock, when turned down and closed. A detachable magazine or pannier, made of tin, can be connected with the right side of the receiver, and is worked by canting the gun to the left, and allowing a cartridge to roll into the receiver in front of the bolt, when it is withdrawn to load.

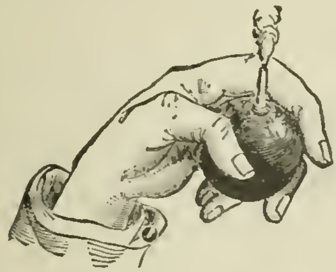
GREENER BULLET.—About 1836 Mr. Greener invented and submitted for trial at Tynemouth, under the authority of the Master General, and Board of Ordnance, a bullet to expand by the action of the powder. It was shaped like an egg, having an opening at one end to receive a taper plug, with a head like a round-topped button, of a composition of lead, tin, and zinc. This plug, which was rather larger near the head than the opening, was driven home on the explosion of the powder, when the sides of the bullet were dilated, and forced into the grooves of the rifle, thereby stopping all windage, and increasing the accuracy of shooting as compared with the Government bullet. The Board of Ordnance rejected this bullet on the ground of its being compound; in 1857, however, Mr. Greener was awarded £1000 "for the first public suggestion of the principle of expansion, commonly called the Minié principle, for bullets, in 1836."

GREENLEAF LITTER.—A combination horse and hand-litter, constructed after the plan of the Indian *travail*. It consists of four ash poles, two for shafts and two for litter-poles; the former are $7\frac{1}{2}$ feet long, 2 inches wide, $2\frac{3}{4}$ inches deep at the butt, and $1\frac{3}{4}$ by $1\frac{3}{4}$ inches at the point; the latter are $8\frac{1}{2}$ feet long, 2 inches wide, and $2\frac{3}{4}$ inches deep, with rounded edges and corners. On one end of the litter-pole are riveted two wrought-iron bands $\frac{1}{8}$ inch thick and $1\frac{1}{2}$ inch wide. One of these collars is set 2 inches from the end of the litter-pole, and has a diameter of $4\frac{5}{8}$ inches by 2 inches; the other is set 12 inches from the end of the poles, and has a diameter of $5\frac{5}{8}$ by 2 inches. The opposite end of the litter-pole is shod with an iron thimble 1 foot long. Two cross-bars, 30 by $1\frac{1}{4}$ by $2\frac{1}{4}$ inches, with a square collar of iron $\frac{1}{8}$ inch thick by $1\frac{1}{2}$ inch wide on each end, serve to keep the poles separated and steady; the collars should have a diameter of 2 by $2\frac{3}{4}$ inches, and the litter-pole must be square at its front end and $2\frac{1}{2}$ feet from the rear end for their reception. A canvas bed 6 feet by 32 inches, with strongly bound eyelets 8 inches apart on the upper end and upper three feet of the sides, and permanently fastened to the lower three feet of the sides, completes the affair. The litter is dragged by a horse or mule hitched into the shafts,—the rear ends of the litter-poles resting on the ground, the patient occupying the canvas bag in the middle. To put it together, the small end of the shaft is passed from behind forward, through the rear and larger collar on the front end of the litter-pole, thence through the smaller collar, and then "pulled home," until the butt of the shafts is tightly embraced by the collars; the cross-bars are then put into their respective places by slipping their collars over the front and rear ends of the litter-poles and pushing them securely home, the canvas bed lashed to the poles by ropes passing through the side eyelets and around the poles, and through the end eyelets and around the cross-bars; the ropes at the head of the bed should be slack, to afford "bag" enough to the canvas to bring the head and shoulders of the patient nearly on a level with his feet. By the arrangement of splicing the shafts to the litter-poles through collars of unequal sizes, a constant tightening of the parts goes on by the force exerted by the animal in pulling the litter, and no opportunity for loosening occurs; while as the greatest weight occurs at this point, additional strength is gained through the iron collar and the double thickness of pole. With a collar and harness, which can be carried without much trouble, the litter can be hitched to an animal by a chain attached to the harness, and having on its end a goose-neck pin to pierce the shaft from below, and be fastened above by a nut or linch-pin. To unship the latter, give a smart blow on the small end of the shaft which will drive it back through the collars, when it can be taken out; remove the cross-bars, unfasten the ropes, and wrap the poles and cross-bars in the canvas, packing the whole thing like a tent on a pack-mule. For use as a hand-litter, it is only necessary to unship the shafts. See *Litter*.



Greenleaf Litter.

GRENADE.—A small shell, about three inches in diameter, of iron or annealed glass, filled with powder, and thrown from the hand. Hurled among dense masses of troops, as those assembled in the ditch of a fortress during an assault, grenades are particularly embarrassing, the splinters inflicting deep wounds and causing great confusion. The discharge is effected by means of a small time-fuse. Grenades are occasionally rolled over the parapet, through wooden troughs, into the trench below; there is also a species of hand-gun fired from a rest, called "musketon," from which grenades may be projected to a short distance. These missiles are said to have been first used in the year 1594. See *Hand-grenade, Projectiles, Rampart-grenade,* and *Shells*.



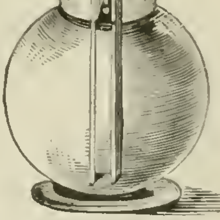
Hand-grenade.

GRENADIER.—Originally a soldier who was employed in throwing hand-grenades, but in modern parlance a member of the first company of every battalion on foot, in which the tallest and finest men of the regiment are placed. This company used to be distinguished from the rest by tall bear-skin caps; it holds the place of honor, viz., the right, when in line, and the front when in column of attack.

GRENADIER GUARDS.—The first regiment of foot-guards in the British Household Brigade of Guards, and generally considered the finest corps in the army. It comprises 2540 officers and men, divided into three battalions. The officers of this fashionable corps are usually from the families of the nobility or more distinguished landed gentry. The First Foot-guards, under which name the regiment was originally known, was first raised in 1660; since then it has ever borne an honorable position in all the wars of the country, and especially in the Peninsula, at Waterloo, and in the Crimea.

GRENADIERS AUXILIARIES.—During the siege, and when a place was closely invested, a certain number of grenadiers were chosen out of the battalions belonging to the trenches, for the purpose of making headway against the besieged, whenever they might risk a sally, or assault the works. It was the peculiar duty of these men to stand forward on every occasion, to set fire to the gabions attached to the batteries, and to crush every attempt which might be made by the garrison to annoy the men that were posted in the trenches, etc.

GRENET BATTERY.—A variety of battery much used for military purposes. It occupies but little space, furnishes an immense quantity of current, is beautiful in design, and, as the zinc can be raised from the fluid, may be kept charged, ready for use, for many months, and can be set in action any time when required, by simply depressing the rod of brass which slides through the center of the cover of the cell, and to which the zinc is attached. For operating induction-coils and electro-medical instruments it is unequaled.



Grenet Battery.

To Make the Solution.—To three pints of cold water add five fluid ounces of sulphuric acid. When this has become cold, add six ounces (or as much as the solution will dissolve) of finely pulverized bichromate of potassa. Mix well.

To Charge the Battery.—Pour the above solution into the glass cell until it nearly reaches the top of the spherical part, then draw up the zinc, and place the elements in the cell. The fluid should not quite reach the zinc when it is drawn up.

Where it is designed to have a battery for occasional service, such as is needed for operating large induction-coils, electric-light experiments, charging large magnets, and for general laboratory work, the plunge-battery is probably the most efficient and convenient yet devised. When not in use the plates are lifted from the solution, but are always ready at a moment's notice. The fluid used is that of the Grenet battery. The plates can be readily detached and replaced at slight expense when necessary, and the jars easily emptied, cleaned, and refilled without taking the plates apart, which, together with the crank-lift, make this battery one of the most convenient ever devised for the purposes to which it is adapted.

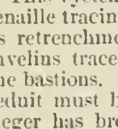
GREVIERES.—Pieces of armor for the protection of the legs and thighs. See *Trumelières*.

GRIBEAUVAL SYSTEM OF ARTILLERY.—About 1765, various improvements were introduced into European artillery by General Gribeauval. He separated *field* from *siege* artillery, lightened and shortened field-guns, and diminished the charges. He adopted elevating-screws, strengthened the carriages, and introduced neater uniformity in the dimensions, enabling spare parts to be carried for repairs. See *System of Artillery*.

GRICES.—A term used in Heraldry to signify the young wild-boars. See *Heraldry*.

GRIENDEL D'ACH SYSTEM OF FORTIFICATION.—This system is a combination of the bastion and tenaille tracings. The enceinte is bastioned and serves as retrenchment; the tenailles are formed of great ravelins traced on the prolongation of the faces of the bastions. The four flanks of the ravelin and its reduit must be destroyed by the mine when the besieger has breached the ravelin. The ditch of the reduit is defended by a double flank constructed on the face of the bastion. Between the tenailles are ravelins with long flanks. The outlay is very great, and the place is much exposed to enfilade.

GRIFFIN.—A chimerical creature, which the fancy of the modern has adopted from that of the ancient world. The griffin is first mentioned by Aristeas, perhaps about 560 B.C., though the accounts of Aristeas seem to be about as fabulous as those of the griffin. The origin of those monstrous conceptions in general, of which the griffin is one, has already been considered under DRAGON. The griffin is variously described and represented, but the shape in which it most frequently appears is that of an animal generated between a lion and an eagle, having the body and legs of the former, with the beak and wings of the latter. In this form it appears on antique coins, and as an ornament in classical architecture. Like all other monsters, griffins abound in the legendary tales of the Teutonic nations, and the name in various forms, slightly differing from each other, is to be found in most Teutonic dialects. Whether in the two cases both the name and the notion might not be traceable to a common source, or whether it was through barbarian or classical channels that they found their way into the nomenclature and the practice of heralds, are subjects on which we do not venture an opinion. Certain it is, however, that there are few fabulous conceptions with which the science of Heraldry is more conversant than the griffin. Nor were they regarded by the patriarchs of that science always as mere creatures of the imagination, for, incredible as it may seem, we find Gerard Leigh, a herald of great reputation in the time of Elizabeth, talking of them with entire sincerity as existing animals. "I think they are of great hugeness," he says, "for *I have a claw of one of their paws*, which should show them to be as big as two lions." In the heraldic griffin, the claws of the eagle are usually substituted for the fore-paws of the lion. Gwillim blazons a griffin in this attitude "rampant," alleging that any fierce animal may be so blazoned as well as a lion. But the more appropriate and usual term is "segreant." In representing the griffin, the ears ought not to be omitted, as they indicate the attribute of watchfulness, which, along with strength and swiftness, went to make up the classical conception of his character. See *Wyvern*.



Griffin.

GRIFFIN GUN.—A name sometimes given to the 3-inch rifle used in the United States field-service, from its inventor, Mr. Griffin, of the Phœnixville Iron-works, Pennsylvania, where the gun was made.

GRINDING-MACHINE.—The use of emery grinding-machines in almost every branch of accurate machine construction is extending every year. Wherever exact cylindrical forms or true plane metal surfaces are required, emery-wheels have been found to be the most effective means of supplementing the work of the lathe and planing-machine in producing exact work. Sir Joseph Whitworth was among the first to develop the true surface-plate system, which he arrived at by scraping the surface and correcting the errors and inequalities by fitting the plates to each other. Two plates may be made to fit each other perfectly and neither be a true plane, because one may be convex and the other concave to correspond; but if one plate is fitted to two others and the latter are both convex or concave, they will not fit each other. Latterly, however, true surfaces are reproduced by moving an object on a perfectly true plane or table over a grinding-wheel in the middle which removes all the projections of the object, and in this way the perfect plane of the table is, so to speak, transferred to the object.

The machine shown on page 787 is intended to produce perfectly true wearing surfaces on various work in this way. The engraving illustrates its construction so clearly that little or no description is needed. The distance from the floor to the center of the spindle is 27 inches. The latter is of steel, 2 inches in diameter, and two- or three-cone pulleys are furnished as may be required. The machine is intended for emery-wheels of 20 inches diameter and 4 inches face, which it will wear down to 9 inches in diameter. The plate for the surface-grinding is 5 feet long and 11 inches wide, and can be elevated and lowered. These machines, in great numbers, are employed in arsenals. See *Emery-grinder*.

GRIP.—1. In some guns the bore is slightly enlarged to within about a caliber in front of the shot-chamber; the intervening portion, which has a less diameter than any other part of the bore, is termed the *grip*. The diameter of this *grip* is the *caliber* of the gun. 2. The handle of a sword.

GRIPES.—A complaint with which horses are often attacked; the remedy recommended is as follows: On the horse being observed to be in pain, he should be trotted about until his bowels are emptied. Should this fail, he must be bled to the extent of two or three quarts, and a ball composed of one drachm of gum opium and two of powdered ginger, made up with bruised meal, given to him, and a clyster of oatmeal gruel every two hours. See *Veterinary Art*.

GROGNARDS.—A term applied to the old soldiers of the French Empire, who were noted for grumbling.

GROINED VAULTING.—In fortification and building, that kind of vaulting in which the vault is not a plain barrel-vault from end to end, but where one vault cuts into another. The angle formed by the intersection is called the groin. In Roman architecture the groins were generally left as a plain sharp edge; in Gothic, they were usually protected and strengthened with *ribs*.

GROMA.—A Roman measuring-rod, about 20 feet long, used for setting off distances in a camp.

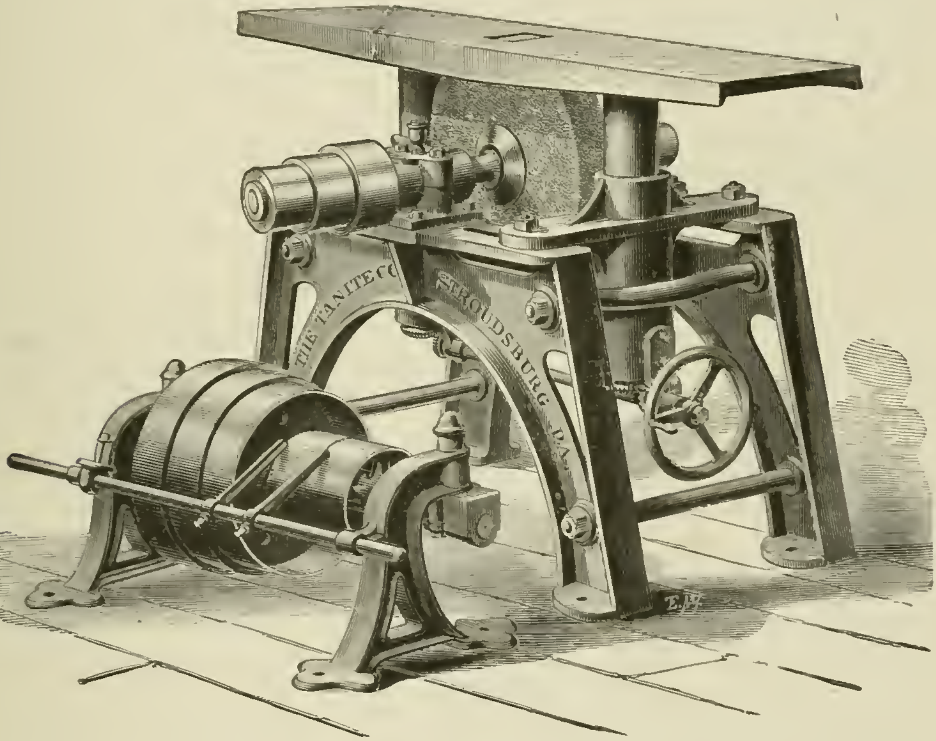
GROMMETS—GRUMMETS.—Circular pieces of rope attached to shot to keep the shot steady in the bore. They are made of various sizes. Grummet-wads are also used when firing at angles of depression, or at angles of elevation less than 3°; the grummet is placed over the shot to prevent it from running out of the piece. The use of grummet-wads with rifled muzzle-loading guns has been discontinued for land-service, except when these guns are firing at a depression. The term *grummet* is applied to a rope ring worked in a particular manner. See *Wad.*

GROOM.—One of several officers of the English Royal Household, chiefly in the Lord Chamberlain's Department; as, the Groom of the Chamber; Groom of the Stole, or Robes.

GROOM-PORTER.—An officer in the Household of the King of England, who succeeded the Master of Revels, and gave directions as to sports.

GROOVES.—The width of the groove generally depends on the diameter of the bore and the peculiar manner in which the groove receives and holds the projectile. Wide and shallow grooves are more easily filled by the expanding portion of a projectile than those which are narrow and deep; and the same holds true of circular-shaped grooves when compared to those of an angular form. An increase in the number of grooves increases the firmness with which a projectile is held, by adding to the number of points which bear upon it. The effect of decreasing the depth of rifle-grooves is, generally, to increase the accuracy but diminish the range. The increase of accuracy undoubtedly arises from the fact that the projectile is held more firmly by the grooves as it passes along the bore; while the diminution of range arises from an increase of friction between the projectile and the grooves. The comparative advantages of uniform and variable grooves depend on the means used to connect them with the projectiles. If the bearing of the projectile in the grooves be long, and the metal of which it is made be unyielding, it will be unsafe, if not impracticable, to employ variable grooves; and if the metal be partially yielding, a portion of the force of the charge will be expended in changing the form of that part of the projectile which projects into the grooves, as it moves along the bore. When the portion in the grooves is so short that its form will undergo but slight alteration, the increasing groove may be used with advantage, as it diminishes the friction of the projectile when it is first set in motion, and thereby relieves the breech of the piece of a portion of the enormous strain which is thrown upon it. If the twist be too rapid toward the muzzle, there will be a danger of bursting the piece in the chase. It is claimed by some that the variable groove is well adapted to expanding projectiles with short bearing surfaces; but the uniform groove, being more simple in its construction, and nearly as accurate in its results, is generally preferred for military fire-arms, both large and small.

The width of a groove depends on the diameter of the bore, and on the peculiar manner in which the groove receives and holds the projectile. Wide and shallow grooves are more easily filled by the expanding portion of a projectile than those which are narrow and deep; and the same holds true of circular-shaped grooves, when compared to those of angular form. An increase in the number of grooves increases the firmness with which a projectile is held, by adding to the number of points which bear upon it. It has been suggested that rifle-cannon, intended for flanged projectiles, should have *four* grooves; as a greater number increases the difficulties of loading, and a lesser number does not hold the projectile with sufficient steadiness. For expanding projectiles, an odd number of grooves is generally employed, for, as this places a groove opposite to a *land*, less expansion will be required to fill them. The number of grooves used in the 3-inch field-gun is *seven*, and the number used in 4½-inch siege-guns is *nine*. The number of grooves in the 4-inch Armstrong gun is *fifty*.



Emery Grinding-machine.

The object of rifle-grooves being to communicate an effective rotary motion to a projectile throughout its flight, it remains to determine what velocity of rotation, or inclination of grooves, is necessary for different projectiles. The velocity of rotation will depend on the form and initial velocity of the projectile, the causes which retard it, and the time of flight; therefore *there is one particular inclination of grooves* *which is best suited to each caliber, form of projectile, charge of powder, and angle of fire.* It has been noticed that if very long projectiles be fired from the rifle-musket, they are less accurate than the ordinary projectile, the length of which is less than two calibers. Mr. Whitworth states that he has known a bullet twice this length turn over end for end within six feet of the muzzle of the English rifle-musket, the caliber of which is nearly the same as that of the American rifle-musket. This instability undoubtedly arises from the want of sufficient rotation around the long axis. What increase of angular velocity must, therefore, be given to compensate for a given increase of length of an oblong projectile?

The resistance which a projectile offers to angular deflection, when rotating around a *principal* axis, is proportional to the moment of its quantity of motion taken with reference to this axis, or M k^2w, M being the mass, k the radius of gyration, and w the angular velocity. Let this expression represent the moment of the quantity of motion around the long axis, and k_1 and w_1 the radius of gyration, and angular velocity, around a short axis, and suppose the angular velocity w and w_1 to be such that the resistance to a deflection from the axes shall be equal: we have $M k^2 w = M k_1^2 w_1$, and by reduction $w_1 = \frac{k^2}{k_1^2} w$. Hence, if we determine by experiment the value of w, the angular velocity necessary to give *practicable* stability of rotation, we can determine the value of w_1, and consequently the superior limit of the deflecting forces. Substituting the value of w_1 in a similar expression for any other projectile, we can determine the angular velocity, and from this the inclination of grooves necessary to give the second projectile steadiness in flight.

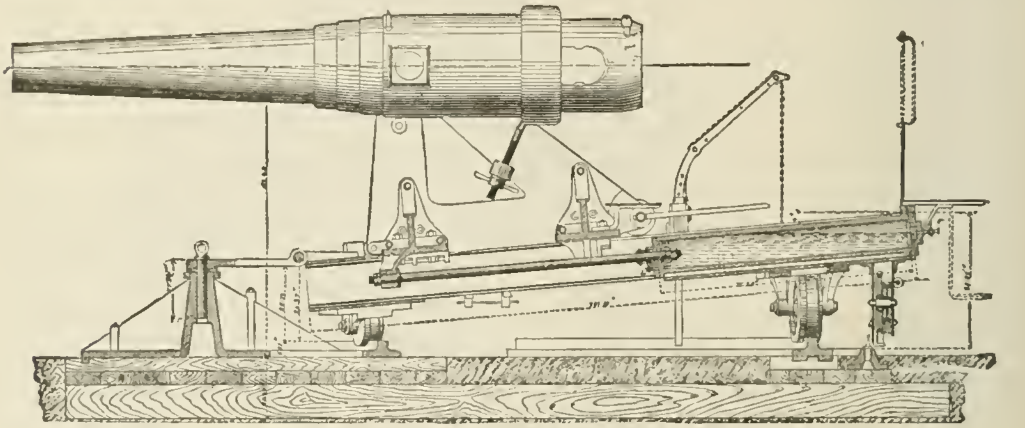
The foregoing method of determining the relation between the lengths of two rifle-projectiles, and the inclination of grooves necessary to give them equal steadiness of flight, is true only under the supposition that they preserve throughout their range the relative angular velocities with which they started. It is necessary, therefore, to consider the causes which affect rotation. The inclination of grooves for a rifle-cannon best suited to a given projectile has not yet been determined by experience; and the consequence is that a wide diversity of "twists" is employed in the various services, and by different experimenters. Colonel Cavalli, in his experiments in Sweden, obtained good results from twists of one turn in 12 feet, and one turn in 35 feet, in a 32-pdr. gun; and a still greater variety of twists have been employed in our own service. For a projectile one and a half diameters long, and 6-pdr. caliber, excellent practice has been obtained with a twist of 25 feet; and in a certain form of the Armstrong gun the twist is 12 feet for a bore 4 inches in diameter. See *Increasing Twist, Twist,* and *Uniform Twist.*

GROS.—Any body of soldiers; a detachment. The French frequently say, *Un gros d'infanterie,* a body of infantry.

GROUND.—A common term in military phraseology, meaning the field or a place of action. What is termed *taking ground* is the extension of a body of troops in any direction. To *gain ground* is to advance; to *lose ground* is to retire or retreat.

GROUND ARMS.—An old word of command, directing the soldiers to lay down their arms upon the ground. It is omitted from the present tactics.

GRUSON SEA-COAST CARRIAGE.—Carriages for guns of 8-inch caliber only have been furnished by Gruson. They differ from the corresponding carriages made by Krupp in this essential particular, that cast-iron is used for several of the important parts in place of cast-steel or wrought-iron, and in consequence a cheaper but heavier carriage is made. The 8-inch guns are of two distinct classes, differing from each other in the distance between the rimbases, being 35 inches and 25.3 inches respectively, and requiring separate carriages. The top-carriage consists of two cheeks of cast-iron, each in one single piece, with a rib on the outside extending around the edge and forming on the lower side a shoe which slides on the rail. The cheek is cut out in the middle to make it lighter, and is reinforced with a rib around the edge of the hole thus formed. The cheeks are connected together by two cast-iron transoms, front and rear, at right angles to the shoe, each held in place by two pins and three bolts. The spaces between the ends of the transoms and the cheeks are filled up with melted zinc, and whenever two pieces of cast-iron are connected together without planing the surfaces, melted zinc is poured into the space between them. The front transom has a cross-head cast to it on its under side to operate the piston-rod, and guides to direct the motion of the top-carriage on the rails. Guide-hooks are bolted on the under side of this transom to prevent any vertical motion of the top-carriage and the bending of the piston-rod. A sheet-iron step rests on two brackets which are bolted to the cheeks in rear of the rear transom, for the man to stand on who elevates or depresses the gun. The rib on the outside of the cheek forms a recess at the front and rear corner for the truck-wheels, which are made of cast-iron bushed with white metal, and provided with lubricating-holes. The axle of the front roller is bolted to the cheek. The rear rollers are slightly larger than the front ones, and are mounted on an eccentric axle. The portion of the axle which passes through the cheek is made larger than the rest and has a circular slot extending about a quarter of the



Gruson Sea-coast Carriage.

circumference around it. A screw set in from the rear end of the cheek plays in this slot and acts as a stop to limit the turning of the axle, and also to prevent it from moving in the direction of its length. There is a hole in the axle on the inside of the cheek for the end of a handspike by which to turn the axle and throw the rollers in or out of gear. The elevating-apparatus consists of a strong screw pivoted on a shaft secured to the left cheek, and a female screw of brass which is operated by means of four handles cast to the lower part of the female screw. India-rubber rings are interposed between the female screw and box to lessen the force of the shock of the recoil on the screw-box. The top-carriage for the smaller gun differs from that just described in this, that the cheeks are bent outwards at the bottom to preserve the same distance between the shoes in the two carriages, so that the same chassis may be used for either, and in having a different elevating-apparatus. The preponderance of these guns, 992 pounds, allows the application of a single elevating-screw under the breech of the gun, a female screw being fitted in a boss on the rear transom. In order to obtain high angles of elevation without having a screw of very great length, a cast-iron cap is placed on the head of the screw between it and the gun, and is kept there for all angles of elevation less than 8°, which corresponds to a range of 3280 yards.

The rails are 12-inch rolled beams, connected together by three transoms of boiler-plate, two at the front and one at the rear end. Wooden hurters are secured to the front end of the rails for the front truck-wheels to strike against. India-rubber counter-hurters are secured to the box-flange of the hydraulic cylinder, and are struck by the guides on the rear transom of the top carriage. The hydraulic cylinder is of cast-iron, 75 inches long and 1.4 inch thick. It has a flange or seat cast on the bottom at each end for securing it to the bottom transom. The rear seat takes the form of an open box, the length equal to the distance between the rails to which it is bolted, as well as to the bottom transom. The ends of the cylinder are turned off square, and are closed by cast-iron covers fitted closely and bolted to the cylinder, a piece of pasteboard saturated in linseed-oil being interposed between the surfaces to make a close joint. The front cover contains the stuffing-box, which is of brass. The rear cover has a recess in the inside, so that the nut on the end of the piston-rod shall not strike it. There is a gauge-cock in the center of this cover to regulate the height of the glycerine in the cylinder. The piston-head is of cast-iron. The four holes in it are reamed out to be parabolic in section; the least diameter is .78 inch. The traverse-wheels are of cast-iron; the front ones are solid and smaller; the rear have spokes. The sole is flat, and the front flange is much stronger than the rear one. The front flange of the rear wheel has holes in its periphery to receive the end of a handspike to traverse the chassis in case the traversing-gear should fail to operate. The traverse-wheel forks are also of cast-iron. The front fork has no rear branch, the wheel being supported only on the front side. The traversing-gear is held in a frame formed of two parallel iron plates bolted by means of angle-irons to the rear bottom transom. It consists of a large grooved wheel for the chain, and four guide-rollers; two with their axles horizontal are grooved like the large wheel; the others have their axles vertical. A large spur-wheel is shrunk on the nave of the chain-wheel, and is driven by a pinion and bevel gears on a cross-shaft which is turned by a crank. The projectile-crane consists of a crane-box of cast-iron bolted to the outside of the right chassis-rail. The crane proper is composed of two parts—the body, which is a round iron rod, and moves freely up and down in the circular hole in the crane-box, and the bent neck, made of two flat bars riveted to the flattened upper end of the body. The neck has two fixed pulleys between the flat bars for the chain to work over. A straight rack is secured to the body at their upper ends, the end of the former being bent at a right angle to itself, with a circular hole in the bent end for the body of the crane to pass through. A shoulder on the top of the body rests on the rack where the body passes through the bent end. The rack is operated by means of a wheel and pinion turned by a crank. A chain with a hook on each end is fastened at one end to the crane-box, passes over the two pulleys, hangs from the end of the neck, and is fastened to the projectile-cart. In raising the crane the projectile is also raised by the shortening of that part of the chain which hangs from the upper roller. The implements are the same as for Krupp's carriage, with the exception of the handspike, which is entirely of iron; and the traversing-gear has two cranks. The weights of the two carriages are as follows:

	Krupp's.	Gruson's.
	Pounds.	*Pounds.*
Weight of top-carriage	4,602	5,512
Weight of chassis	10,830	8,819
Total weight	15,432	14,331

See *Sea-coast and Garrison Carriages.*

GUARANTEE ASSOCIATION.—An Association in England which for a small percentage undertakes to vouch for the prudence and fidelity of such public officers as Paymasters, Ordnance Storekeepers, Commissaries, Staff Officers of Pensions, Barrack Masters, etc. The Government accepts the guarantee of this particular office in preference to that offered by private individuals.

GUARD.—1. A body of men whose duty it is to secure an army or place from being surprised by an enemy. Camp and garrison guards are relieved every twenty-four hours. The guards at outposts are ordinarily relieved in the same manner, but this must depend on their distances from camp, or other circumstances, which may sometimes require their continuing on duty several days. In such cases they are previously warned to provide themselves accordingly. All persons, of whatever rank in the service, are required to observe due respect toward sentinels. The *countersign*, or watchword, is given to such persons as are entitled to pass during the night, and to officers, non-commissioned officers, and sentinels of the guard. Interior guards receive the countersign only when ordered by the Commander of the troops. The *parole* is imparted to such officers only as have a right to visit the guards, and to make the grand rounds; and to officers commanding guards. Sentinels are relieved every two hours, unless the state of the weather, or other causes, should make it necessary or proper that it be done at shorter or longer intervals. Those at the guard-house or guard-tent are the first relieved and left behind. Each relief, before being posted, is inspected by the Commander of the Guard. The Corporal reports to him, and presents the old relief on its return. If the sentinels are numerous, the Sergeants are employed, as well as the Corporals, in relieving them. Sentinels do not take orders or allow themselves to be relieved, except by an officer or non-commissioned officer of their guard or party, the Officer of the Day, or the Commanding Officer; in which case the orders are immediately notified to the Commander of the Guard by the officer giving them. Sentinels report every breach of orders or regulations they are instructed to enforce.

2. A position in bayonet and saber exercises, executed as follows:

With the Bayonet.—Bring the left toe nearly to the front; carry the right foot three inches to the rear, the heel two inches to the right of the left, the feet at right angles. (Two.) Carry the right foot fifteen inches to the rear, feet at right angles, knees slightly bent, the body resting equally on both legs; at the same time bring down the piece into the left hand, the little finger at the lock-plate, thumb along the stock, the right hand at the small of the stock, the barrel turned slightly to the left, the butt three inches in front of the body and a little below the belt-plate, the point of the bayonet in front of and at the height of the chin, both arms half extended, the left elbow near the body. All movements in the bayonet-exercise, not specially excepted, are executed from guard, to which position the piece is restored after every movement by the command *guard*. The position is shown in Fig 1.

With the Saber.—Carry the right foot about two feet to the right, heels on the same line; place the left hand, closed, six inches from the body, and as

Fig. 1.

Fig. 2.

high as the elbow, the fingers toward the body, little finger nearer than the thumb (position of the bridle-hand); at the same time place the right hand in tierce in front of and a little higher than the right hip, thumb extended on the back of the gripe, little finger by the side of the others, the point of the saber inclined to the left, and two feet higher than the hand, which grasps the saber without constraint. The position is shown in Fig 2. To return to the *carry*, the Instructor commands: 1. *Carry*, 2. Saber. At the command *saber*, the recruits resume the position of the soldier, and come to the *carry*. See *Bayonet-exercise, Fencing*, and *Saber-exercise*.

GUARD-DETAIL.—The men from a company, regiment, or other organization detailed for guard-duty. The First Sergeant keeps the roster and makes this detail.

GUARD-DUTY.—In a general sense, that duty performed by a sentinel. This duty in peace is much more severe than is generally supposed, and usually requires that during the 24 hours of its continuance the sentinel shall make a march under arms of some 16 miles for one third of the time, and be "present for duty equipped" at a moment's notice always. If this happened once a week it would be often enough. Coming, as it does, twice or thrice, it imposes more labor and exposure than all other military duty, and year after year of it tells. There are two ways of meeting this trouble; one by relaxing the regiments of guard-duty to some extent, and one by enlarging the number of men upon whom it is imposed. Its proper performance, so far as security of buildings and stores is concerned, or even the restriction of travel to certain directions, does not require a full uniform or even a 14-pound musket. "To take charge of all public property in view," when nothing can be seen by the naked eye but a 20-ton gun and a chain pump, hardly demands that a man should pace majestically back and forth from one to the other forever. He would be just as useful if he carried a switch and came round at intervals; if, in fact, he dared to consider himself less of a sentinel and more of a watchman. In these days of telephones, when offices, stables, quarters, etc., can all be put into immediate communication with one another, and a man at his desk may in a moment summon into his presence, or receive a report from, anybody, whether a Police Sergeant or Post Surgeon, the time-honored formalities and display of guard-duty may well be relieved of much that is out of date and out of use. It can be made much less mechanical and tedious with no loss of value. See *Guard*.

GUARD-HOUSE.—The building occupied by the guard. The prisoners being kept in the building, it is frequently used as a synonym for prison-room or lock-up. *To take one to the guard-house* is to confine him. See *Guard-room*.

GUARD-MESS.—The table which is kept for the officers of the Life and Foot Guards in St. James's Palace. The sum of £4000 per annum is allowed for the Mess.

GUARD-MOUNTING.—The military ceremony of marching on guard. At the *assembly of guard-details*, the men warned for duty fall in on their company parade-grounds, in two ranks, facing to the right, non-commissioned officers and supernumeraries falling in as file-closers; each First Sergeant then faces his detail to the left, verifies it, fixes bayonets, brings the detail to rear open order, inspects the dress and general appearance, replaces by a supernumerary any man whose condition makes him unfit to march on guard, and then brings the detail to close order. The band takes post on the regimental parade, so that the left of its front rank shall be twelve yards to the right of the front rank of the guard when the latter is formed. At *adjutant's call*, the Adjutant and Sergeant-major march to the regimental or garrison parade, the Sergeant-major on the left; the details are conducted to the parade by the First Sergeants, the band playing in quick or double time. Upon arriving on the parade-ground, the Sergeant-major takes post facing to the left, 12 yards to the left of the front rank of the band; the Adjutant takes post so as to be 12 yards in front of and facing the center of the guard when formed. The detail which arrives first is so conducted to the line that, upon halting, the breast of the right front-rank man shall be near to and opposite the left arm of the Sergeant-major. The Sergeant having halted his detail, places himself in front of and facing the Sergeant-major, at a distance equal to or a little greater than the front of his detail; he then commands: 1. *Rear open order*, 2. March. At the second command, the ranks are opened, the front rank dresses up to the line of the Sergeant-major and First Sergeant, the right front-rank man placing his breast against the left arm of the Sergeant-major; the rear rank steps back and halts three yards in rear of the front rank; the non-commissioned officers three yards in rear of the rear rank; and the supernumeraries three yards in rear of the non-commissioned officers. Seeing the ranks opened, the Sergeant commands, Front; salutes the Sergeant-major, and reports: *The detail is correct*; or, (So many) *Sergeants, Corporals*, or *privates, are absent*. He then passes by the right of the guard, and places himself three yards in rear of his supernumeraries. The other details, as they arrive, form in a similar manner on the left of the first; each First-Sergeant places himself opposite the left of his detail, faces the Sergeant-major, opens ranks, salutes, reports, and places himself in rear of his supernumeraries as already prescribed; the rear rank, the non-commissioned officers and supernumeraries of each detail, dress on the rear rank, the non-commissioned officers and supernumeraries of the detail next preceding; the rear rank closes to the right. The company details alternate in taking the right of the line. The Sergeant-major returns the salutes with the right hand, draws his sword, verifies the details, causes the guard to count fours, completing the left four as in the School of the Company, if necessary, and then divides the guard equally into two platoons; after which he commands: 1. *Right*, 2. Dress. The Sergeant major verifies the alignment of the ranks, file-closers, supernumeraries, and First Sergeants, and then returns to the right of the front rank, faces to the left, commands, 3. Front, passes to the center of the guard, turns to the right, halts midway to the Adjutant, salutes, and reports: *Sir! The details are correct;* or, *Sir!* (so many) *Sergeants, Corporals*, or *privates, are absent*. At the order, *Take your post*, the Sergeant-major faces about, approaches to within two yards of the center of the guard, and, turning to the right, places himself facing to the front, three yards to the left of the front rank. The Sergeant major having reported, the Officers of the Guard post themselves facing to the front, three yards in front of the front rank, and draw sword, the Senior opposite the center of the first platoon, the Junior opposite the center of the second platoon; if there be but one officer, he places himself in front of the center of the guard. The Adjutant superintends the formation, returns the salute of the Sergeant-major with the right hand, draws his sword, and commands: 1. *Officers and non-commissioned officers, to the front and center*, 2. MARCH. At the command *march*, the Officers of the Guard advance, closing toward each other, and halt at three yards from the Adjutant; the non-commissioned officers pass by the flanks, and form in the order of rank from right to left, three yards in rear of the officers. The Adjutant then assigns their places in the guard according to rank, as follows: *Senior Officer, Commander of the Guard, and chief of the first platoon; Junior Officer, chief of the second platoon; Senior Sergeant, right guide and guide of the first platoon; Second Sergeant, left guide and guide of the second platoon; the remaining non-commissioned officers as file-closers of the first and second platoons.* The Adjutant then commands: 1. *Officer and non-commissioned officers*, 2. *To your posts*, 3. MARCH. At the command *march*, the Junior Officer of the Guard and the non-commissioned officers take the posts assigned them, the Junior Officer placing himself three yards in front of the center of the second platoon, the non-commissioned officers passing around the flanks. If there be but one Officer of the Guard, the Adjutant commands: 1. *Non-commissioned officers*, 2. *To your posts*, 3. MARCH. The Senior Sergeant takes his post in the line of file-closers opposite the center of the second platoon. The officers and non-commissioned officers having taken their posts, the Adjutant directs the Commander of the Guard, *Inspect your guard, Sir;* at which he faces about, commands, 1. *Order*, 2. ARMS, 3. *Inspection*, 4. ARMS, returns his sword and inspects the guard. During the inspection the band plays. The Adjutant, during the inspection, returns his sword, observes the general condition of the guard, and replaces any man who does not present a creditable appearance by a supernumerary from his company. He also, when so directed, selects, as Orderly for the Commanding Officer, the soldier who is neatest in general appearance, and notifies the Officer of the Guard of his selection. When there are two Officers of the Guard, the Junior may, at the discretion of the Senior, inspect the rear rank. If there be no Officers of the Guard, the Adjutant inspects, and the Sergeants designated as chiefs of platoon place themselves in the line of file-closers, opposite the centers of their platoons. If the guard be too small to be divided into platoons, the Senior Sergeant, who commands the guard, places himself on the right of the front rank, and is covered by the right guide in the rear rank. The inspection ended, the Adjutant places himself about thirty yards in front of and facing the center of the guard, and draws sword; the Officers of the Guard place themselves three yards in front of the centers of their respective platoons, and draw sword; if there be but one, he places himself three yards in front of the center of the guard; at the same time the Officers of the Day take post in front of and facing the guard, about thirty yards or more from the Adjutant, the old Officer of the Day three yards to the right and one yard to the rear of the new Officer of the Day. The Adjutant then commands, 1. *Parade*, 2. REST, 3. SOUND OFF. The band, commencing on the right, plays along the line in front of the Officers of the Guard to the left, and back to its place on the right, when it ceases. The Adjutant now commands: 1. *Guard*, 2. ATTENTION, 3. *Carry*, 4. ARMS, 5. *Close order*, 6. MARCH. At the command *march*, the officers face about, and place themselves two yards in front of their respective platoons. The Adjutant then commands, 1. *Present*, 2. ARMS; faces to the new Officer of the Day, salutes, and reports: *Sir! The guard is formed.* The new Officer of the Day, after acknowledging the salute with the right hand, directs the Adjutant: *March the guard in review, Sir.* If the Adjutant be senior to the Officer of the Day, he reports without saluting; the Officer of the Day then salutes and gives the Adjutant the same directions as before; the Adjutant returns the salute. The Adjutant faces about, brings the guard to a *carry*, and commands: 1. *Platoons right wheel*, 2. MARCH. At the first command, the chiefs of platoon, if not already there, place themselves two yards in front of the centers of their respective platoons. At the command *march*, the platoons wheel to the right on a fixed pivot, as explained in the School of the Company; the band wheels to the right and places itself twelve yards in front of the first platoon. The Adjutant places himself abreast of the first platoon and six yards from its left flank; and the Sergeant-major six yards from the left flank of the second platoon. The Adjutant then commands: 1. *Pass in review*, 2. *Forward*, 3. *Guide right*, 4. MARCH. The guard now passes in quick time past the Officer of the Day, according to the principles of review, the Adjutant, the chiefs of platoon, Sergeant-major and Drum-major saluting. If senior to the Officer of the Day, the Adjutant does not salute. The band, having passed the Officers of the Day, wheels to the left out of the column, and places itself opposite the Officers of the Day, and facing them, ceasing to play when the rear of the column has passed; the trumpeters or field-music detach themselves from the band when the latter wheels out of the column, and remain in front of the guard. The guard having passed the Officers of the Day, the Adjutant and Sergeant-major halt, return their swords and retire. The Commander of the Guard wheels it into line to the left without halting, breaks it into column of fours to the right, places himself on the left of the leading guide, and, preceded by the trumpeters, who begin to play when the band ceases, conducts his guard to its post. The Officers of the Day face toward each other and salute, the old Officer of the Day giving the old or standing orders to the new Officer of the Day. While the band sounds off, and the guard is marching in review, the Officers of the Day stand at parade rest with arms folded. They both come to attention before the guard is to be presented, and as the head of the column approaches. The new Officer of the Day returns the salute of the Drum-major, should there be one, with the right hand, and uncovers while the guard is passing, holding his hat with the right hand over the left shoulder. The First Sergeants and supernumeraries come to *order arms*, *parade rest*, and *attention*, with the guard; they remain at *order arms* while the guard is being presented and wheeled into column. The senior First Sergeant commands, 1. *Parade*, 2. REST, at the command *march* for passing in review, and, 1. *Supernumeraries*, 2. ATTENTION, when the Officers of the Day come to attention. The First Sergeants come to *parade rest*, and to *attention* with the supernumeraries. The rear of the column having passed the Officers of the Day, the senior First Sergeant commands, 1. *Carry*, 2. ARMS, after which each First Sergeant marches his supernumeraries to the company parade and dismisses them. The guard, if too small to be divided into platoons, may be wheeled to the right and passed in review as above; the Commander of the Guard is two yards in front of its center; the Adjutant is six yards from its left flank, the Sergeant-major covers him on a line with the file-closers. The Officer of the Day may direct the Adjutant: *March the guard to its post, Sir.* The Adjutant faces about, brings the guard to a *carry*, and then commands: 1. *Guard to its post*, 2. *Fours right*, 3. MARCH (or, *Double time*, MARCH). At the second command, the Senior Officer places himself facing to the right, two yards in front of the right guide; the Junior Officer places himself in the line of file-closers in rear of the center of the second platoon. At the command *march*, the guard wheels by fours to the right; the trumpeters or field-music place themselves in its front; the Senior Officer takes command and places himself on the left of the leading guide; the Adjutant and Sergeant-major return swords and retire, and the First Sergeants march off their supernumeraries; the Officers of the Day salute each other as before, and the band retires. As the new guard approaches the guard-house, the old guard is formed in line, with the trumpeters or field-music two yards to its right; and, when the trumpeters or field-music of the new guard arrive opposite its left, the Commander of the old guard commands: 1. *Present*, 2. ARMS. The new guard having passed, he commands: 1. *Carry*, 2. ARMS. The new guard marches in quick time past the old guard, arms at a *carry*, officers saluting. The trumpeters having marched three yards beyond the trumpeters or field-music of the old guard, change direction to the right, and, followed by the guard, change direction to the left when on a line with the file-closers of the old guard. The change of direction is without command; the Senior Officer of the Guard halts on the line of the front rank of the old guard, allows his guard to march past him, and, when its rear approaches, wheels it by fours to the left, halts it, establishes the left guide three yards to the right of the trumpeters or field-music of the old guard, and on a line with its front rank, and then dresses his guard to the left; the trumpeters or field-music of the new guard are two yards to the right of its front rank. The new guard being dressed, the Commander of each guard, in front of and facing its center, commands, 1. *Present*, 2. ARMS, resumes his front, and salutes. The officers, having saluted, face their guards, and command: 1. *Carry*, 2. ARMS, 3. *Order*, 4. ARMS. Should the guards be commanded by Sergeants, they present with their guards, standing on the right or left of the front rank, according as they command the old or new guard. If one guard is commanded by an officer, the other by a non-commissioned officer, the latter stands on the flank of his guard and salutes with it. The Officer of the new guard now divides the guard into three reliefs, numbers them *first*, *second*, and *third*, from right to left, and directs a list of the guard to be made; experienced soldiers are placed over the arms of the guard and at the remote and responsible posts; the Officer of the Guard then proceeds to take possession of the guard-house or guard-tent, and the articles and prisoners in charge of the guard. During the time of relieving the sentinels and of calling in the small posts, the two guards stand at place rest, and the old Commander gives to the new all the information and the instructions relating to his post. The first relief having been designated and brought to a carry, its Corporal commands: CALL OFF. Commencing on the right, the men call off alternately front and rear rank: *one*, *two*, *three*, *four*, and so on; the Corporal then commands: 1. *Right*, 2. FACE, 3. *Support* (or, *Right shoulder*), 4. ARMS, 5. *Forward*, 6. MARCH. The Corporal marches on the left, and near the rear file, in order to observe the march. The Corporal of the old guard marches on the right of the leading rank, and takes command when the last one of the old sentinels is relieved, changing places with the Corporal of the new guard. When the relief arrives at fifteen yards from a sentinel, he halts and faces to it, with arms at a carry. At six yards from him the Corporal commands: 1. *Relief*, 2. HALT. The Corporal then adds, according to the number of the post: 1. *No.* (——), 2. *Arms*, 3. PORT. At the third command the two sentinels come to *arms port*, and approach each other. The old sentinel, under the supervision of both Corporals, whispers his instructions to the new sentinel; both then come to a *carry*. The Corporal then commands: 1. *Support* (or, *Right shoulder*), 2. ARMS, 3. *Forward*, 4. MARCH. As the relief passes, the old sentinel takes his place in its rear at a support (or right shoulder) arms; the other sentinels are relieved in a similar manner. The sentinel at the guard-house is the first relieved, and is left behind. The detachments and sentinels of the old guard, having come in, form on its left, and both guards are brought to a carry; the Senior Officer of the old guard then marches it, with the guide right, six yards to the front, when he commands: 1. *Fours right*, 2. MARCH. At the command *march*, the guard wheels by fours to the right, the trumpeters or field-music begin to play, and the guard marches in quick time past the new guard, which stands at *present arms*, officers of both guards saluting. The Commander of the new guard, if an officer, stands two yards in front of its center while the old guard is passing; if a non-commissioned officer, he stands on the right of the front rank. The new guard is brought to a carry as soon as the old guard has passed, and, when the latter has marched about fifty yards from the post of the guard, the Commander of the new guard orders his men to stack arms, or to place them in the gun-racks. The Commander of the Guard then makes himself acquainted with all the instructions for his post, visits the sentinels, and questions them and the non-commissioned officers relative to the instructions they have received from the old guard. On arriving on the regimental or garrison parade, the Officer of the old guard forms it in line and halts it, orders the company details composing it two yards to the front, and sends them, under charge of non-commissioned officers or privates, to their respective companies. Before the men are dismissed, the cartridges are drawn, or discharged at a target. When the details return to their companies, the chiefs of squad examine the arms and accouterments of their men, and cause them to be put away in good order. The Officers of the Day visit and inspect the guard-house, or tents, while the old guard is being relieved, verify the number of prisoners, and then proceed to the office or presence of the Commanding Officer, who receives the report of the old Officer of the Day, relieves him, and delivers his instructions to the new Officer of the Day. In visiting the guard-house the Officers of the Day will each be saluted by his own guard, its Officer commanding: 1. *Present*, 2. ARMS. When other officers entitled to a salute approach, the Senior Officer of the two guards commands: 1. *Old and new guards*, 2. *Present*, 3. ARMS. In rendering honors, the Commander of the Guard, if an officer, stands in front of its center, faces about to command *present arms*, resumes his front, and then salutes; he also faces about before commanding *carry arms*, and again resumes his front. If a non-commissioned officer commands the guard, he presents and carries arms with it, standing on the right of the front rank. When a small detachment is mounted for guard, as at a one-company post, the officer mounting it brings the detachment to rear open order, and, after having inspected it, places himself in front of and facing it, and commands: 1. *Parade*, 2. REST, 3. SOUND OFF. The trumpeters or field-music sound off, standing on the right, after which the guard is brought to close order, and without presenting (unless there be an Officer of the Day) is marched direct to its post by the commands: 1. *Guard to its post*, 2. *Right*, 3. FACE, 4. *Forward*, 5. MARCH. The non-commissioned officer commanding the guard during the mounting stands on the right of the front rank. In conducting the guard to its post he marches near its left and rear, where he can see its movements. A file-closer, if there be one, takes his place as guide. The same honors are rendered at the guard-house as already explained. If the guard be armed with the saber, the commands at guard-mounting are modified to meet the requirements of the arm used.

Mounted guard-mounting is conducted in single rank on the same principles as guard-mounting dismounted, with the following modifications: No supernumeraries are formed with the guard; the First Sergeant inspects the dress and general appearance of his detail before causing it to mount. The sabers of the First Sergeants are drawn; the sabers of the details are in the scabbard. The officers and non-commissioned officers take the distance of six yards from the rank when at open order, and one yard when at close order; the First Sergeants, in reporting, salute with the saber, and then place themselves six yards in rear of the non-commissioned officers of the guard. The assignment of officers and non-commissioned officers is omitted, the non-commissioned officers remaining in the position above prescribed; the guide of each platoon is the file on the flank toward which the guide is announced. If any man does not present a creditable appearance, the Captain is notified through the First Sergeant, and sends a man to the Officer of the Guard, at the guard-house, to replace him. If there be no Officer of the Guard, the Adjutant, when inspecting, notifies the senior two non-commissioned officers to serve as chiefs of platoon; or, if the division of platoons be omitted, he notifies the senior non-commissioned officer to command the guard; the non-commissioned officer places himself on the right of the rank. The Adjutant omits the commands *parade rest* and *guard attention*, and, to present the guard, commands: 1. *Draw*, 2. SABER, 3. *Present*, 4. SABER. The platoons wheel to the right. The Officers of the Day do not fold their arms, and the First Sergeants, having taken their posts, remain at attention till the rear of the guard has passed the Officers of the Day, when they return their sabers and immediately retire. See *Grand Guard-mounting* and *Undress Guard-mounting*.

GUARD OF HONOR.—The guard drawn up to receive royal personages and persons of distinction, and to attend at state ceremonials. It consists, as a general rule, of 100 rank and file, with a Captain in command, two subaltern officers (one carrying the first color), and a proportion of Sergeants. The regimental band attends when the Queen or other exalted person is to be received.

GUARD-REPORT.—The report which the Officer or Non-commissioned Officer in Charge of a Guard sends in to headquarters on dismounting. The report of his tour of service always includes the outposts. The following is the form of the report:

Report of a Guard mounted at ——, on the——, and relieved on the ——.

	Lieutenants.	Sergeants.	Corporals.	Musicians.	Privates.	Total.	Aggregate.	Articles in charge.				Received the foregoing. A. B., —— ——, *Officer of the Guard.*
Parole.												
Countersign.												
Detail.												

LIST OF THE GUARD.

Reliefs and when posted.											Where posted.	Remarks.
First relief from —— to —— and —— to ——.				Second relief from —— to —— and —— to ——.			Third relief from —— to —— and —— to ——.					
No.	Name.	Co.	Reg't.	Name.	Co.	Reg't.	Name.	Co.	Reg't.			
—	——	—	——	——	—	——	——	—	——			
—	——	—	——	——	—	——	——	—	——			
—	——	—	——	——	—	——	——	—	——			

Sergeant: Corporal:

Orderly for Commanding Officer: Best Shot:

LIST OF PRISONERS.

Name first the prisoners under sentence by G. C. M., commencing with those who have longest to be confined.

No.	Names.	Co.	Regiment.	Confined. When.	Confined. By whom.	Charges.	Sentence. Commenced.	Sentence. Expires.	Sentences.	Remarks.
—	——	—	——	——	——	——	——	——	——	——
—	——	—	——	——	——	——	——	——	——	——
—	——	—	——	——	——	——	——	——	——	——
—	——	—	——	——	——	——	——	——	——	——
—	——	—	——	——	——	——	——	——	——	——

—— ——,
—— *Regiment of* ——,
Commanding the Guard.

GUARD-ROOM.—The room occupied by the guard during its tour of duty. There is a room in the guard-house in which prisoners awaiting the investigation of their crimes are kept. Under the same roof a room is attached in which the Officer Commanding the Guard resides during his tour of duty.

GUARDS.—The élite of the troops in all armies, and usually those most heavily armed. In the British service, the Guards constitute, in time of peace, the garrison of London, and the guard of the Sovereign at Windsor. The Guards compose what is called the Household Brigade, and include in cavalry the 1st and 2d Life-guards, and the Royal Horse-guards (blue), and in infantry the Grenadier Guards, the Coldstream Guards, and the Scots Fusilier Guards. These distinguished corps comprise 1302 cavalry in three regiments, and 5940 infantry in seven battalions. Before the abolition of purchase, the officers of the regiments

Royal Horse-guardsman (1742).

of Foot-guards held higher army rank than that they bore regimentally; that is, Ensigns ranked with Lieutenants of other regiments, Lieutenants with Captains, Captains with Lieutenant-colonels; and on exchanging into the Line, they were thus enabled to exchange into the higher positions, a circumstance which often placed officers of comparatively short service over veterans of the Line, and caused, perhaps, more heart-burning than any other anomaly among the regulations. When purchase was the rule, every officer in the Guards was quite ready to accede to it; when it was abolished in 1871, this exceptional rank was also abolished in regard to all officers newly entering the Guards.

GUARD-SHIP.—The ship of war in charge of a port. She generally acts also as a depot for seamen raised there until appropriated to other vessels, and her Captain is responsible for the safety and proper preservation of the men-of-war which may be laid up—out of commission—in the harbor. The Superintendent of a dock-yard, if a Flag-officer, carries his flag at the mast-head of the guard-ship; if he be only a Captain, the guard-ship is usually under his nominal command, although the actual duties are carried on by the Commander or next Senior Officer.

GUARD'S INSTITUTE.—An establishment in London which consists of reading-rooms, lecture-rooms, etc., for all officers and soldiers in the metropolis. It was inaugurated by the Duke of Cambridge, July 11, 1867.

GUARDS OF THE TRENCHES.—In a siege-operation, to protect the workmen from sorties, as many battalions of the line as may be requisite, termed the *Guards of the Trenches*, are thrown forward about thirty paces in advance of and on the flanks of the men who open the first parallel. The flank companies of these battalions, divided into sections, cover the front of the battalions, and are posted about thirty paces from them; and each section posts two sentinels at about the same distance to its front. The sentinels keep a lookout, kneeling on one knee; the remainder of the troops lie flat on the ground to avoid the fire of the defenses. When the working-parties are all posted, the men of each lying flat until all are ready to commence the work, the order is given to rise, ground their arms a few paces to the rear, and break ground. The guards of the trenches keep their position until near dawn, when they are withdrawn and take post in the parallel, which, by this time, is nearly excavated to its full width.

GUARD-TENTS.—The tents occupied by the guard, when a command is in the field or camp.

GUASTADOURS. — Turkish Pioneers. Armenians and Greeks are generally employed in the Turkish armies to do the fatigue-work that is necessary for the formation of a camp, or for conducting a siege.

GUDDA.—The Indian term for a fool; also a small fort erected upon a hill or eminence.

GUDDEELAH.—Indian name for a padded cloth placed on the back of a draught-elephant before the harness is put on. It is made of kurwah cloth stuffed with cotton, the edges being bound with leather.

GUDGEON.—The circular part of a shaft or axle upon which a wheel revolves. The gudgeons on cast-iron axles are simply parts of the extremities of the axles turned exactly circular in a lathe. The circular apertures in which the gudgeons turn are called *brasses;* they are made of a composition of copper and tin, and are very durable, as well as not readily worn by the friction of the iron axles. The beams in which the brasses are fixed are called "bearings."

GUELPHIC ORDER.—An Order of Knighthood for Hanover, instituted by George IV. when Prince Regent, on August 12, 1815. It is both a military and civil order, unlimited in number, and consisted originally of three classes—Knights Grand Cross, Commanders, and Knights—to which the Revised Statutes of 1841 have added another class of simple members. The Grand-Mastership is vested in the Crown of Hanover. The badge of the Order is a gold cross surmounted by the Hanoverian Crown—between each division of the cross is a lion passant gardant. In the center is the horse courant of Hanover, surrounded by a blue circle, and the motto, *Nec aspera terrent.*

GUELPHS AND GHIBELLINES. — The names of two great parties, the conflict of which may almost be said to make up the history of Italy and Germany from the eleventh till the fourteenth century. The origin of these names was formerly the subject of much speculation; but antiquarians are now agreed in tracing them respectively to the two families, Waiblingen and Welf, which in the twelfth century were at the head of two rival parties in the German Empire, and whose feuds came to be identified historically with the respective principles for which these parties contended. The actual origin of the assumption of the names is commonly fixed at the great battle of Weinsberg, in Swabia, 1140 A.D., in which the two rival claimants for the Empire, Conrad of Hohenstaufen, Duke of Franconia, and Henry the Lion, of the House of Welf, Duke of Saxony, rallied their followers by the respective war-cries, "Hie Waiblingen!" "Hie Welf!" but it is certain that the names were in use from an earlier date, although, probably, rather as representing the family feud than the political principles which the two families afterwards severally supported. As the chief theater of the conflict of these parties was Italy, the original names took the Italian form of *Ghibellini* and *Guelfi*. The former may, in general, be described as the supporters of the imperial authority in Italy, the latter, as the opponents of the Emperors; and as the opposition to imperial authority in Italy arose from two distinct parties, which, for the most part, made common cause with each other—from the Church, which asserted its own spiritual independence, and from the minor principalities and free cities, which maintained their provincial or municipal rights and liberties—the history of the struggle is involved in much confusion, and is variously related, and its merits variously appreciated, according to the point of view from which it is regarded. To the churchman, it is the struggle of the Church against the State; to the friend of popular principles, it is the conflict of liberty against absolutism and centralization. The same individual—as, for example, the poet Dante—is found to change sides in the struggle. For the most part, however, the interests of the Church in these mediæval contests, although regarded by Protestants as excessive in degree, must be confessed to have fallen in with the claims of political and personal freedom. Five great crises in the strife of the Guelph and Ghibelline parties are commonly noted by historians: under Henry IV., in 1055; under Henry the Proud, in 1127; under Henry the Lion, in 1140; under Frederick Barbarossa, in 1159; and in the pontificate of the great champion of churchmanship, Innocent III. The cities of northern Italy were divided between the two parties—Florence, Bologna, Milan, and other cities, as a general rule, taking the side of the Guelphs; while Pisa, Verona, and Arezzo were Ghibelline. The great Italian families, in like manner, took opposite sides; but the policy of each family frequently varied from one generation to another. In general it may be said that the nobles of the more northern Provinces of Italy inclined to the Ghibelline side, while those of the central and southern Provinces were Guelph. By degrees, however, especially after the downfall of the preponderance of the German Emperors in Italy, the contest ceased to be a strife of principles, and degenerated into a mere struggle of rival factions, availing themselves of the prestige of ancient names and traditional or hereditary prejudices. Even in 1272 Gregory X. could with truth reproach the Italians with their sanguinary animosities for the sake of what were but names, the meaning of which few of them could understand or explain; and in the following century, in 1334, Benedict XII. practically disallows altogether the reality of the grounds of division between the parties, by prescribing, under pain of the censures of the Church, the further use of those once-stirring names which had long been the rallying-words of a sanguinary warfare.

GUERITE.—A small loop-holed turret in the wall of a fortress, from which a sentry may command a view and fire over the ditch. Guerites are generally fixed to the acute points of bastions.

GUERRE.—War; warfare; art of war; dissension; strife. *En guerre*, at war; in action; ready for action; any piece of ordnance unlimbered, trunnions shifted, and everything made ready for firing.

GUERRILLAS.—The name given in Spain to the armed bands, composed of peasants and shepherds, who, on occasion of foreign invasion or civil wars, carry on an irregular warfare on their own account. From 1808 to 1814 they were regularly organized against the French, and, being favored by the charac ter of the country, were successful on various occasions, especially at the commencement of the war, under Empecinado, the Pastor Merino, Mina, and other leaders. The country itself suffered from the Guerrillas, who revenged political treachery, or even the barest suspicion of it, by fearful devastations. Many of them, and particularly Mina's band, joined Wellington, and after having undergone a course of discipline, rendered signal service as regular troops. In all the recent civil wars of Spain, the Guerrillas, especially those of the Basque Provinces, acted a prominent part on the Carlist side.

When Guerrillas are taken captive, they should be treated according to the usual customs of war. In the Franco-German War, the Germans refused to recognize as soldiers, or extend the privileges of war, to the *Francs-Tireurs*—a body of French volunteer sharp-shooters who, to a great extent, adopted this system of guerrilla warfare. See *Partisan*.

GUERRILLERO.—An irregular soldier; a member of a guerrilla band or party. See *Guerrillas*.

GUET.—A term attached to those persons belonging to the French body-guard who did duty during the night. It also signified rounds, or those duties of a soldier, or patrolling-party, which are prescribed for the security of a town, etc., and to prevent surprises. It is also taken in a military sense in conjunction with other words; as, *guet à pied*, foot-patrol; *guet à cheval*, horse-patrol, etc.

GUEUX.—The name assumed by the confederated nobles and other malcontents who opposed the tyrannical policy of Philip II. of Spain in the Low Countries. Philip having sent nine Inquisitors to that country to put into execution the decrees of the Council of Trent, provoked by this act the bitter resentment of the Protestants, as well as of the Catholics and nobility, who saw in it an attempt to curtail their ancient liberties. A party of opposition was thus formed, and, headed by Counts Louis of Nassau and Henry de Brederode, declared in an Act called the "Compromise," which was remitted to the Regent Margaret, their fixed determination to ignore utterly the authority of the Inquisitors. On the admission of a deputation from them to an audience, the Regent seemed somewhat unnerved by their bold front, and inclined to yield to their demands; when one of her Council approached her, and whispered that she "need not be afraid of these gatherings of beggars." The remark having been overheard by some of the deputation, the abusive epithet was assumed as the title of their Association. As the sign of fraternity, each of the "Beggars" wore a medal known as the "Beggar's Denier," formed of gold or silver, and stamped on the obverse with the image of Philip II., and the inscription, "In everything faithful to the King;" and on the reverse with a wallet, such as the mendicant monks carried, held in two hands, with the words, "Even to carrying of the wallet." The "Beggars" maintained a long and vigorous contest against the despotic proceedings of Philip and his advisers, but were ultimately compelled to succumb to superior force. A branch of them, "The Beggars of the Sea," under the bold leadership of the savage Count de la Marck, were almost uniformly successful in their enterprises: they several times defeated the Spanish fleet, captured transports with supplies for Alva's army, captured several fortresses, and succored besieged places along the coast.

GUICHETS.—Small doors or outlets which are made in the gates of fortified towns. They are generally four feet high, and two broad, so that a man must stoop to get through. In garrison towns the guichet is usually left open for the space of one quarter of an hour after retreat, in order to give the inhabitants time to enter.

GUIDES.—1. The non-commissioned officers, and other enlisted men, who take positions to mark the pivots, marches, formations, and alignments in modern discipline. The French call them *jaloneurs*. Guides and file-closers always execute *order arms*, *fix* and *unfix bayonets*, and *carry arms*. In rendering honors they execute the *present*, *reverse*, and *rest on arms*. On drill they execute the *support* and *right shoulder arms*, except the guide of each subdivision in column when marching in common or quick time, and the guides who mark the line of battle during its formation. They execute the other movements of the manual only when specially directed.

2. In military affairs, guides are usually persons drawn from the country in which an army is encamped. A sufficient body of intelligent men is collected at headquarters to enable one or more to be sent with every detachment of troops which leaves the camp. A guide should be quick of eye, experienced in the topography of the country, and, above all, faithful. As, however, guides must on most occasions be drawn from the midst of a hostile population, and have probably only a pecuniary interest in serving well, their conduct is always watched with the utmost jealousy, death being awarded as the punishment for the least departure from trustworthiness. Any treason or incompetence on the part of a guide might involve the most disastrous consequences to a whole expedition. In the French army a considerable corps of cavalry and infantry bear the name, but the name only, of "guides." They were first formed in 1744, as a small company of messengers on active service. The number was gradually increased until the time of Napoleon I., who formed them into a guard 10,000 strong.

Trustworthy guides are invaluable, but most rare, in an enemy's country. The best, from the information they acquire by their habits of life, are to be found among those classes whose avocations keep them much abroad, going from place to place within a certain sphere constantly; such as common carriers, hunters, smugglers, etc. Among the first things to be attended to by an officer, in taking post at any point, is to find out persons of this class, and to ascertain their whereabouts when wanted. Kind treatment, *douceurs*, and promises should not be spared, to enlist either their good-will or their interests; and, if policy requires it, they may openly be treated with apparent harshness, to screen them from odium among their neighbors. If none of this class can be found, then resort must be had to a higher; local authorities being in preference selected, and if necessary forced to act. Here very careful treatment is requisite; when the necessity of the case is admitted by them, much may be gleaned by kindness, courtesy, and a certain deference, from such persons, that cannot be looked for from their inferiors. Before starting on his mission, the officer should question his guide thoroughly; and if he has several, question each apart; like precautions should be taken with respect to other inhabitants. Care must be had to find out the usual beats of one taken as a guide, so as not to take him out of his own neighborhood. In all cases, the guide must be well watched, however trustworthy he may seem. If unwilling or sulky, he must, if needs be, be tied, and attached to a strong man, with a rope around his middle; being first strictly searched for any cutting instrument about him. Should there be but one guide, he must necessarily be placed with the most advanced portion of the detachment accompanying the officer. If there are several, one must be there also; the one apparently the most intelligent with the officer, who should ply him with questions; and the others in the rear, strictly guarded. It may be well to remark that guides are useful even in a country of easy communications; as, in case of a rencontre, they may point out byways convenient for retreat, if necessary.

3. In the Indian army the name of "guides" is given to a regiment of cavalry and infantry attached to the Punjab frontier force. It was raised by the late Sir Henry Lawrence, chiefly with the view to the men acting as scouts, and obtaining every available information about the country they happened to be in; also to act in expeditions as *avant-couriers*

of the force to which they belonged, and (the cavalry branch) in carrying orders that required dispatch.

GUIDON.—1. One who carries a flag. Also, one of a community of guides established at Rome by Charlemagne to accompany the pilgrims to the Holy Land.

2. A small flag or streamer usually carried by the mounted troops. It is broad at the one end and is nearly pointed at the other. It is sometimes used to direct the movements of infantry, and to make signals at sea.

In the United States army, each company of the mounted troops has a silken guidon, and the names of battles in which companies or batteries in the service of the United States have borne a meritorious part are inscribed upon their guidons. Within the spirit of this regulation, battles are important engagements between independent armies in their own theaters of war, in contradistinction to conflicts in which but a small portion of the opposing forces are actually engaged—the latter being called, according to their nature, "affairs," "combats," skirmishes," etc. A battle has for its object the determination of important questions of policy or strategy; an engagement may be partial, and yet, if it tend to these ends, it is also entitled to the dignity of being termed a battle. The portion of a regiment which must be engaged in a battle to entitle the regiment to have inscribed upon its colors the name of the battle is that number of companies which by tactics and the regulations is entitled as a battalion, habitually, to carry the colors of the regiment. The inscriptions on the guidons of artillery batteries do not include the honors to which the regiment is entitled, but those won separately by detached mounted batteries.

The guidons for cavalry are made of silk, with stars and stripes like the national flag; made swallow-tailed. Stars gilt, one and one eighth inches in diameter from point to point. The guidon measures from the lance three feet five inches to the end, and fifteen inches to the fork of swallow-tail, and two feet three inches on the lance. The fork of the swallow-tail is equidistant from the top and bottom of guidon. The letter of the company is embroidered in yellow silk, or painted on one of the white bars of the flag. The lance is one and one fourth inches in diameter, and nine feet long, including spear and ferrule.

When mounted, the heel of the staff rests in the socket attached to the right stirrup; the right hand grasps the staff at the height of the elbow. The guidon salutes as follows: (*First motion:*) Lower the staff by straightening the arm to its full extent. (*Second motion:*) Bring back the staff to the habitual position. Dismounted, the heel of the staff is supported at the right hip, and, in saluting, the guidon, in the first motion, slips the right hand along the staff to the height of the eye before lowering the staff.

GUIGE.—A belt of the Middle Ages, by which the shield was secured to the person of the wearer, and also carried by him without inconvenience, suspended about his neck.

GUILLOTINE.—The instrument of decapitation introduced during the French Revolution by the Convention, and named after its supposed inventor, Josephe Ignace Guillotin, a Physician, who, however, it is ascertained, was only the person who first proposed its adoption. It is composed of two upright posts, grooved on the inside, and connected at the top by a cross-beam. In these grooves, a sharp iron blade, placed obliquely, descends by its own weight on the neck of the victim, who is bound to a board laid below. The speed and certainty with which this machine separates the head from the trunk gives it a great superiority over the axe or sword. The invention of machines of this kind is ascribed to the Persians. In Italy, from the thirteenth century, it was the privilege of the nobles to be put to death by a machine of this kind, which was called *mannaia.* Conradin of Swabia was executed by such a machine at Naples, in 1268. An instrument resembling the guillotine was likewise employed in Germany during the Middle Ages. During the sixteenth and till late in the seventeenth century, a machine called the *maiden*, which differed but slightly from the guillotine, was employed in Scotland for the purpose of decapitation. That such an apparatus was known and used in France at an earlier period is proved by the execution of the Duc de Montmorency, who is described as having been executed by a falling axe at Toulouse, in 1632. The Dutch, too, in the eighteenth century employed a decapitating machine in executing slaves in their Colonies.

GUILTY.—The form of verdict given by a Jury or Court in criminal cases when the crime charged has been found proved. In England, there are only two verdicts which can be given in such cases, viz., Guilty or Not Guilty; but in Scotland there is an intermediate verdict, called "Not Proven," which, though in reality a verdict of Not Guilty (and it is so entered in England), yet is allowed to be given by Juries when they are not satisfied that sufficient legal evidence has been given, but nevertheless consider there was some foundation for the charge, or at least some ground for suspicion. It has been objected to this verdict that it leaves a stigma on the party; nevertheless it is firmly adopted in the law and practice of Scotland.

GUISARME.—A lance having a small axe fixed at the foot of its blade or lance-head on one side and a spike projecting on the other side. It was popular in the sixteenth century. See *Gisarme.*

GUISARMIERS.—French foot-soldiers (piétons) of the free archers, armed with the *guisarme.*

GULES.—The term by which the color red is known in Heraldry. In engraving it is marked by perpendicular lines traced from the top of the shield to the bottom. It is supposed to indicate valor, magnanimity, and the like, and is regarded as the most honorable heraldic color. See *Heraldry.*

GUN.—A term applied in its most general application to fire-arms of any description, but in the more restricted and technical sense to cannon. A gun is a frustum of a right cone, with a cylinder excavated round the axis, to serve as a bore. Close home to the end of this cylinder the powder is driven, and outside it is the ball to be expelled. The trunnions are cast in one mass with the piece, and are placed in the second reinforce in such a position that the breech-end of the gun outweighs the muzzle. Their axis is generally about half their diameter below the axis of the piece. This locality has several conveniences; but for the maximum of steadiness in the recoil, it has been shown that the axes of the trunnions and of the gun should exactly intersect. The use of the trunnions is to suspend the cannon on its carriage in such a manner that it may be readily depressed or elevated, but so that it shall have no horizontal motion which is not shared by the whole carriage. The vent or touch-hole, the channel through which the charge is fired, is a small cylindrical orifice leading at an angle from the breech of the bore towards the base-ring. The explosion within reacts with great force on the lower portion of the vent, and in case of rapid or long-continued firing soon honeycombs the iron or brass, often dislodging considerable fragments. This, besides diminishing the regularity of the action of the powder upon the projectile, would involve danger of bursting if permitted to any great extent. The gun so affected is therefore *bouched*, that is, has a new vent constructed. This process consists of drilling a female screw, of larger than the required diameter, in the metal of the gun. Into this matrix a bar of pure copper is screwed (copper being the metal least liable to fuse under the intense heat of ignited gunpowder), and the vent is then drilled through the copper. Sir A. Dickson devised the following simple mode: he rammed a cartridge of sand firmly into the breech, then filled the vent and all the interstices with molten copper, and had only to bore a hole through the latter to complete the operation. In cases of great urgency, even this simple procedure may be

GUNS. 1. Gun with match-lock. 2. Rotary-lock. 3. Flint-lock. 4. French hunter's gun. 5. Cossack gun. 6. Russian infantry gun. 7. Prussian needle-gun. 8. Section of lock of Prussian needle-gun. 9. Prussian needle-gun cartridge. 10. Prussian ovate-ball cartridge. 11. Lefaucheux gun, with shot cartridge. 13. Bouveum gun. 14. Chassepot rifle. 15. English Enfield rifle. 16. Its cartridge. 17. Section of latter. 18. Austrian gun, Wänzel's pattern. 19. Remington rifle. 20. Peabody gun. 21. Cartridge, and 22, ball thereof. 23. Pfyffer gun. 24. Spencer's repeating carbine. 25 Section thereof, and 26, cartridge. 27. Henry's repeater. 28. Prussian needle carbine. 29. American carbine 30. Colt's revolver. 31. Lefaucheux revolver. 32. Lefaucheux cartridge. 33. Russian Minié-gun. 34. Bavarian case-cartridge. 35. Bavarian expanding ball. 36. English expanding ball, with wooden plug. 37. French expanding ball, ancient form. 38. Recent form of the same. 39. Swiss ordnance cartridge, with compressed powder. 40. Box cartridge, with peripheral fire. 41. Baden expanding projectile. 42. Ploennis' expanding projectile. 43. Lorenz's compressed projectile. 44. Old pointed projectile.

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shortened by the insertion of the stem of a tobacco-pipe during the filling; the pipe, on being removed, leaves a perfect vent. A gun is suited to fire hollow as well as solid projectiles; and the only limit to the charge is the strength of the projectile to resist rupture in the piece. The employment of shells in the heavy cannon, after the manner of solid shot, constitutes the basis of what is known as General Paixhan's System of Artillery, and not the peculiar form of the gun, as is generally supposed. The caliber of a gun is generally expressed in terms of the weight of a solid cast-iron ball of the size of the bore. See *Cannon*, *Ordnance*, and *Small-arms*.

GUN-BARREL.—The iron for all good musket-barrels contains a portion of steel, or undergoes some kind of steeling process. Horseshoe-nails or stubs, after much violent usage, yield a very tough kind of iron when reheated; and English gun-makers have been accustomed to buy such refuse on the Continent. The best barrels are now made of laminated, twisted, and Damascus steel. To prepare *laminated steel*, Mr. Greener, a celebrated Birmingham gunsmith, collects scraps of saws, steel pens, files, springs, and steel tools from the various workshops; cuts them into small and nearly equal pieces; cleans and polishes them by revolving in a cylinder; fuses them into a semi-fluid state; gathers them into a "bloom" or mass; forges this bloom with a three-ton hammer; hardens and solidifies it with a tilt-hammer; rolls it into rods; cuts each rod into pieces six inches long; welds these pieces together; repeats the rolling, cutting, and welding several times; and thus finally brings the metal into a very hard, tough, fibrous, and uniform state. *Twisted steel* for barrels is made by taking thin plates of iron and steel, laying them alternately one on another in a pile, welding them by heat and hammering, and twisting them by very powerful mechanical agency, until there are twelve or fourteen complete turns to an inch; the length becomes reduced one half and the thickness doubled by this twisting. *Damascus steel* barrels are made of steel which has undergone a still further series of welding and twisting operations. *Stub Damascus* barrels are made of a mixture of old files with old horseshoe-nails; the files are heated, cooled in water, broken with hammers, and pounded in a mortar into small fragments; three parts of these fragments are mixed with five of stub; and the mixture is fused, forged, rolled, and twisted. An inferior kind of Damascus twist is made by interlaying scraps of sheet-iron with charcoal, and producing an appearance of twist, but without the proper qualities. *Threepenny-skelp* and *twopenny-skelp* are inferior kinds of barrel-iron; and the worst of all is *sham-dam skelp*, of which gun-barrels are made for hawking at a cheap price at country-fairs, and for barter with the natives in Africa and the backwoods and prairies of America. The gun-barrel manufacture of England is now almost wholly conducted at Birmingham and at Enfield, very few barrels being made elsewhere. The best barrels are all twisted into form. The skelps, or long strips of prepared steel, are twisted into a close spiral a few inches long; several of these spirals are welded end to end; and the fissures are closed up by heating and hammering. The rough barrel, with a core or mandrel temporarily thrust in it, is placed in a groove, and hammered cold until the metal becomes very dense, close, strong, and elastic. The interior is then bored truly cylindrical by a nicely-adjusted rotating cutting-tool. If, on narrow inspection, the interior is found to be straight and regular, the exterior is then ground on a rapidly revolving stone, and finally turned in a lathe. Commoner barrels are not twisted: the skelps are heated, laid in a semi-cylindrical groove, hammered till they assume the form of that groove, placed two and two together, and heated and hammered until one barrel is made from the two halves. Common barrels are browned externally with some kind of chemical stain; but the best are rubbed with fine files, and polished with steel burnishers.

Comparatively few realize the amount of labor and expense required to manufacture shotgun-barrels that have a fancy figure, and the component parts of which are iron and steel. These barrels must be light, therefore thin, and yet sufficiently strong—conditions which can only be obtained by an extraordinary tenacity of the material. In these combinations this tenacity is secured by mixing and blending the iron and steel so intimately together that the peculiar proportions of each, toughness and elasticity, are imparted to every portion of the mass, and the barrel thus receives the degree of hardness and softness required. The barrels of the celebrated Parker gun are manufactured in the following manner: The iron and steel are placed in layers according to the figure that may be desired, which operation is called *piling*. These layers are securely welded together into a compact bar, as shown in Fig. 1, which must be absolute-

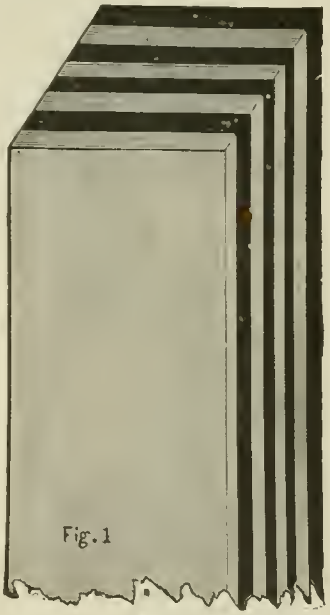


Fig. 1.

ly sound and perfect in every weld, as the slightest spot left unwelded or unsound in this operation will be sure to cause a total loss of the barrel. The process now consists in reducing this bar to such a sized rod as may be required for a certain weight of barrel. This rod is now twisted similar to a rope, as shown at E in Fig. 2, care being taken to have the twist uniform and even. Several of these twisted rods are now placed side by side, being careful to have the inclination of the twist arranged in opposite directions, as shown in the illustration. These several rods are welded together with the same care and precision as in the previous operation, to insure perfectly sound barrels. This is now termed a ribbon and is coiled spirally around a mandrel, as shown at F in Fig. 2. This spiral ribbon is raised to a welding heat and jumped by striking the end against the anvil, thereby welding the edges firmly together. They are then placed upon a welding-mandrel, reheated, and welded from end to end. Much skill and care are required in this operation to reduce the outside diameter to correct size and at the same time preserve the caliber, and also maintain the proper taper, the barrel being much larger at the breech than at the muzzle. The fine figure that appears in the figured barrel is dependent upon the correctness of this and the previous welding operations, for if hammered unevenly, the figure itself will be correspondingly uneven. Then follows the process of hammering in nearly a cold state, whereby the texture of the metal is condensed, closing its pores and making it harder. This finishes the operation of barrel-forging, and the barrel is now ready to be bored, turned, and finished upon lathes manufactured expressly for the purpose. The curly figure that appears in the Damascus, Bernard, and laminated barrels, as shown at G in Fig. 2, is obtained by twisting the rods before referred to, as appears in the illustration at E in Fig. 2, the variation of figure being ob-

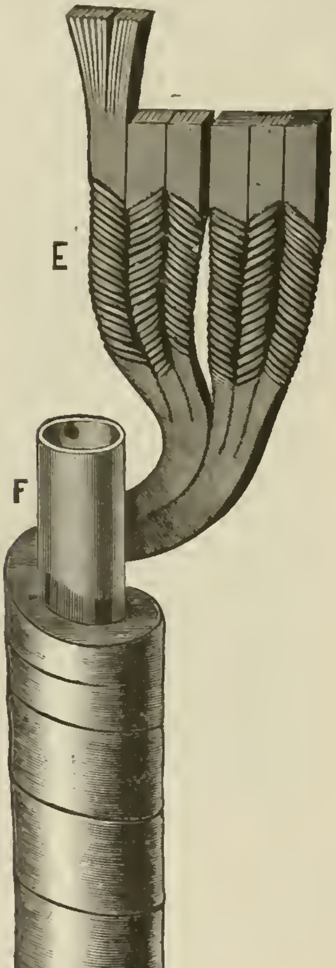


FIG. 2.

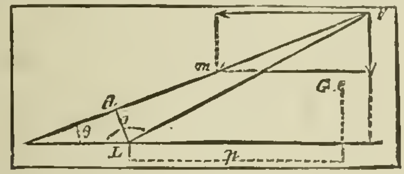
tained by varying the piling. The white marks that appear in the finished barrel are iron, and the dark ones the steel. The fine figure that is on the barrels of the high-priced guns is obtained by an increased number of pieces in the operation of piling. This larger number of pieces necessarily renders the operation of securing perfect welding much more difficult, and the liability of loss is greater. Some imagine that the curly figures of the barrels are simply etched on the outside, when they are, in fact, the visible proof of a superior strength both desirable and important to every shooter who cares for his personal safety; for if an iron barrel, no matter how strong and thick, is defective and does not stand the test, the defective part will splinter into more or less small pieces, while the Damascus, Bernard, and laminated barrels will tear like a woven fabric. This proves clearly the extraordinary tenacity of the material. These fine barrels are not, therefore, worked and twisted so neatly and nicely that they may look beautiful alone, but rather for the reason that greatest lightness, combined with greatest durability, may be produced.

Each barrel, after manufacture, should be carefully tested and submitted to the necessary proof. The diameter of the bore should be verified with the standard and limit gauges. The standard gauge is a cylinder of the diameter of the bore, and the limit gauge is .0025 inch greater. The former should pass freely through the bore, and the latter should not enter it. The barrel should enter the groove of the stock, one half of its diameter, and it should bear uniformly throughout, particularly at the breech. The *vent* should be accurate in its dimension, position, and direction, and a wire should be passed through it, to see that it is free. The *cone* should be sound. The shoulders of the *breech-screw* should fit closely to the end of the barrel, and it should be free from cracks or flaws about the tang screw hole. The *straightness* of the barrel may be ascertained by turning out the breech-screw, and holding the barrel up to the light, and reflecting the image of a straight-edge from the surface of the bore. If the barrel be straight, the reflected image will be straight in all positions of the barrel. The bore must be free from all hammer-marks, ring-bores, cinder-holes, flaws, cracks, etc., as such irregularities cause an inaccuracy of fire. See *Barrel*.

GUN-BOAT.—A small boat or vessel armed with one or more guns of heavy caliber. From its small dimensions, it is capable of running close inshore or up rivers, and from the same cause it has little chance of being hit by a larger vessel at the long range which the carrying power of its guns enables it to maintain. On the outbreak of the Russian War (1854–56), as the British Navy was without a single gun-boat, a large squadron of them was hastily constructed in 1855 and 1856, but too late for that special war. From the haste with which they were put together, most of those vessels proved defective. Their tonnage was small; and their armament usually consisted of one 8-inch gun and one 100-pounder Armstrong gun. In the last two wars with China, gun-boats performed excellent service, having penetrated nearly to Peking, and far up the Yang-tze-kiang. Gun-boats in their more modern form are small mastless vessels mounting one large gun in the bow, and propelled by an engine with single or twin screws. The gun is pointed by means of the helm or the screws, and the gun-boat is in fact a floating gun-carriage. The *Staunch*, the first gun-boat built on this principle for the English navy, has given her name to the whole class. These gun-boats usually carry an armor-piercing gun of 18 tons, on a draught of only 4 feet. But they have been designed to carry even 35-ton guns. Four have lately been built by the Messrs. Armstrong for the Chinese navy—the *Alpha*, *Beta*, *Gamma*, and *Delta;* two of these carry a 25-ton gun, and two a gun of over 30 tons. A small flotilla of such gun-boats, protected only by their small size, would be in coast-defense formidable opponents even for ironclads. At the beginning of the century the United States had over 250 of these vessels; but the "gun-boat system" was soon abandoned. Some of the Continental Navies are well provided with gun-boats.

GUN-CARRIAGES.—Gun-carriages are designed to transport cannon from one point to another, and to support them when fired. A suitable gun-carriage, therefore, should allow the piece to be easily and promptly pointed in the direction of its object; it should be capable of being served by the smallest number of men, and transported with the greatest ease; its recoil, under fire, should be restrained within suitable limits; and it should have sufficient strength and stability to resist overturn or injury from the greatest service-charge. The injury to the carriage arising from the recoil of the piece increases with the square of the velocity of the recoil, which is dependent on the relation between the weight of the carriage and the weight of the piece. Generally speaking, the piece should be heavier than the carriage. Artillery-carriages, like the cannon which they support, are classified into *field*, *mountain*, *prairie*, *siege*, and *sea-coast* carriages. The sea-coast carriages, not being required for the transportation of their pieces, differ materially from the others in their construction.

In every case the carriage must be so constructed as to effectually meet the forces to act upon it. As the axis of the bore intersects the axis of the trunnions, the entire force of the charge, acting on the bottom of the bore, is communicated to the carriage at the trunnion-beds. The carriage being constructed symmetrically with regard to the axis of the piece, we are at liberty, in the following discussion, to suppose that the wheels, trunnion-beds, and trail are all situated in the same plane, and that the resultant of the force of the charge is applied at the point where the axis of the trunnions pierces this plane. The action of the force of the charge is to move the carriage along the surface of the ground (supposed to be horizontal), to press the wheels and trail upon the ground, and to rotate the carriage around the point of contact of the trail with the ground. Let v be the



position of the axis of the trunnions, and mv represent the amount and direction of the force of the recoil, and θ the angle of fire. Let L be the point of contact of the trail and ground, a the distance of this point from the trunnions, α the angle which the line joining these two points makes with the horizontal, G the position of the centre of gravity, and p its horizontal distance from the point L. If mv be the force of the recoil, R and C the pressures exerted by it upon the wheel and trail respectively, we have the relation

$$mv \sin \theta = R + C.$$

The horizontal component acts to overcome the friction of the wheel and trail, and to set the carriage in motion. By making f the unit of friction, and MV the quantity of motion impressed on the carriage, we have

$$mv \cos \theta = f(C + R) + MV;$$

or, by substituting the value of $R + C$ from the above equation, and solving with reference to V, we have

$$V = \frac{mv(\cos \theta - f \sin \theta)}{M},$$

which is the velocity of recoil. As the unit of friction of the wheel and trail are not exactly the same, the foregoing equation will not give a strictly correct value for V for field- and siege-carriages, but it will be correct for fortress carriages and mortar-beds, which do not move on wheels, in recoil. The force mv also acts to rotate the carriage around the point L with an effect proportional to its lever-arm Ld, which is equal to $a \sin dvL$; but $\sin dvL = \sin [180° - (\alpha + \theta)]$, and the moment of the force of the charge, with reference to the trail, is $mva \sin [180° - (\alpha + \theta)]$. This moment being equal to the moment of the weight of the piece, and the moment of the quantity of motion impressed upon the carriage, or P, we have

$$mva \sin (180° - \alpha - \theta) = Wp + P.$$

But $P = \frac{Wk^2w}{g}$; k being the radius of gyration of the gun and carriage taken with reference to the trail, g the force of gravity, and w the angular velocity of the gun and carriage. Substituting this value of P in the above equation, and reducing, we have

$$w = g\frac{mva \sin (180° - \alpha - \theta) - Wp}{Wk^2}.$$

With this relation we can discuss, by giving different values to θ, α, a, and p, the effect of the angle of fire, length of trail, position of trunnions, and center of gravity, on the stability of the carriage, or the resistance which it offers to overturning by the force of the charge acting at the center of the trunnions.

Stationary carriages consist of two parts, the carriage—or, as it is usually called, the top-carriage—and the chassis, and, with the exception of that for the flank-casemate howitzer, are always constructed of wrought-iron. The top-carriage is composed of two cheeks, held together by two plates of boiler-iron, called the front and rear transoms. Each cheek is formed of two plates of boiler-iron cut to a triangular shape, separated by interposing at the edges the vertical portion of a T-shaped bar. The horizontal branches project over each side to form a double flange, giving stiffness to the cheeks. Flat bars of iron are placed between the plates at suitable intervals to stiffen the cheeks in the direction in which the weight and recoil of the piece bear upon them. All these parts are held together by screw-bolts. The piece rests between the cheeks, and is supported on them by the trunnions, which work in circular cavities called *trunnion-beds*. This permits the piece to have free play for purposes of elevation and depression.

For most pieces, the motion of the top-carriage to and from battery is regulated by a pair of truck-wheels, one on each side, which work on an eccentric axle placed underneath and a little in front of the axis of the trunnions. The wheels are thrown *into gear* by means of handspikes inserted into sockets upon the ends of the eccentric axle; the wheels then rest upon the top of the chassis-rails, and only the rear part of the soles of the top-carriage rest on the chassis-rails and have sliding friction. The wheels are thrown *out of gear* in the same manner; the entire soles then have sliding friction upon the chassis-rails, thus checking recoil. In the 15-inch gun-carriage there are two pairs of truck-wheels, one pair being placed in front, as just described, and the other pair near the rear end of the carriage; the rear wheels only are on eccentric axles, and when these are *out of gear* the soles of the top-carriage rest fairly on the chassis-rails, and the motion is on sliding friction. When the rear wheels are *in gear* the front wheels also touch the chassis-rails, and the top carriage moves on rolling friction. To prevent the rear wheels from working *out of gear* while the gun is being run from battery, or jumping *in gear* when the piece is fired, pawls are provided for locking the rear axle.

When the rear wheels are *in gear*, motion is communicated to the carriage by means of a handspike on each end of the front axle. This handspike carries a double pawl, which works in ratchets or cogs on the truck-wheels. The handspike is arranged with a counterpoise, consisting of a heavy piece of iron on the short arm of the lever. In the 10- and 15-inch guns, as also in mortars, the elevation and depression are given by means of a lever, called the *elevating-bar*. The point of this bar works in ratchets cut in the breech of the piece. The fulcrum—usually called the *ratchet-post*—rests on the rear transom of the gun-carriage. It is of cast-iron, and has several notches for adjusting the position of the elevating-bar. Carriages for the 8-inch rifle (converted) have an improved elevating-apparatus. Guns of the Parrott pattern have an elevating-screw. This is attached to the rear transom of the carriage at its lower end, while the nut is connected to the cascabel of the gun. The screw is worked by a handle passing through it above the nut. Both screw and nut admit of movements by which the screw can take any position required in the various degrees of elevation. See *Chassis, Field-carriages, Ordnance, Sea-coast and Garrison Carriages, Siege-carriages*, and *Traveling-carriage.*

GUN-CARTRIDGE.—A bag in which the charge of powder is placed before the cartridge is inserted in the gun. The size and form of cartridges depend on the nature of the guns with which they are to be used, and the purpose for which they are required. They are made of serge, silk (a material made entirely from refuse silk), and raw hide—serge for service, silk for saluting or exercising, and raw hide for drill purposes. Experience has shown that serge is hardly strong enough for heavy charges; silk cloth, therefore, which is much stronger, is likely to take its place. Serge or flannel cartridges are hooped (stitched round with rings of thread or broad braid), which tends to keep them in their proper shape when filled. In examining cannon-cartridges (filled or empty) care should be taken to see that the flannel is perfectly sound throughout, and the sewing uninjured, and free from all appearance of moths. If filled, the powder should be free from all lumps or dust. Dust in powder in any package or parcel of cartridges will be shown by the flannel appearing black and dusty on the outside. To restore the cartridge, if the powder has become caked by pressure, gentle rolling will bring it to its proper state; but if it has been caked from wet, it cannot be restored without injury to the grain. Cartridges which are injured by moths, or have the flannel torn or damaged, or of which the powder has been wetted and caked, or which is very dusty, are unserviceable.

GUN-CONSTRUCTION.—The change from the former comparatively light smooth-bore gun to the heavy rifled cannon of the present day, throwing an elongated projectile of at least three times the weight of a spherical shot of the same caliber, has led to the almost entire abandonment of cast-iron, unaided by other metals, for gun-construction, and to the trial and adoption in its stead of metals of higher tensile strengths and elastic limits, as forged iron and steel. It is true that the Italian military authorities, and especially those of France, have experimented quite extensively with combinations of cast-iron and steel for heavy guns with good results; the present naval and sea-coast armament of the latter nation being made up in great part of such guns.

It seems, however, that neither of these nations is disposed to rest satisfied with this combination of material for gun-construction. In fact, the French have instituted trials with all steel, and recently with steel wire-wrapped guns. Herr Krupp's rifled guns are made solely of forged steel. They have been adopted in Germany, Austria, and by some of the minor Powers of Europe. Though the Armstrong and Woolwich guns are constructed essentially of wrought-iron, we infer from various sources that English opinion, in common with that of the Continent, points to the use of steel in some shape as the future material for heavy guns both for land and naval service. The combinations of this material, as well as those of wrought-iron, known as the built-up system, thus far tried with more or less success, consist of a lining tube surrounded by concentric rings or cylinders of greater or less length, connected together by methods varying with the ideas of the designers, as in the Krupp, the Woolwich, and the Armstrong systems.

These different systems all agree in this, that the assemblage of parts shall produce compression upon the inner layers and extension upon the outer, so as to call forth in the most effective manner the resistance of the several rings when subjected to the strains due to the explosion of the charge. Though long since a recognized fact that the penetration of projectiles into iron increases far more rapidly with velocity of impact than with weight of shot, it is only within a few years that changes in gun-construction have been initiated looking to a large increase of initial velocities. These recent changes have involved great increase in the length of gun and in the capacity of the powder-chamber, by which means about one third additional velocity of projectile has been reached, and, notably, in the 9.45-inch Krupp gun, and in the wire-bound Armstrong gun recently constructed and tried, about one half. The leading military nations of the world, though already provided to some extent with guns of medium power, more or less satisfactory, are now looking for such combinations of metals as will produce a stronger gun capable of burning a very large charge of powder so as to attain the highest possible initial velocities with safety.

Steel in some form seems to be regarded as the best metal to accomplish that end. The fact that steel wire can be produced with more than twice the tensile strength of steel forged as rings has probably induced the recent construction, for trial, of wire-bound guns both in England and France. It is understood that so far as these trials have progressed the results are favorable, indicating the attainment of high velocities. Now, the forging of the large masses from which the rings are produced by boring, that constitute the successive layers of the steel gun, involves a very expensive plant, is a very slow and costly process, and does not result uniformly in the attainment of a perfectly homogeneous metal. It would therefore be economy and probably give better results if the outer layers of the gun could be replaced by steel in a shape more readily produced and possessed of greater tensile strength. It is in part with this view that steel wire seems to have been suggested for wrapping under initial strains the interior tube and next consecutive concentric bands of the steel gun. The wire by its great tensile strength cannot fail to impart the requisite tangential strength to the structure. The only apparent difficulty of the combination is in the parts that give resistance to longitudinal strains developed in the firing. Dr. W. E. Woodbridge, who seems to have been the inventor or suggester of the wire gun, has attempted to attain resistance to transverse rupture, other than that due to the great friction of the parts, by uniting them by brazing with bronze. In Sir William Armstrong's wire gun, resistance to longitudinal strains is effected by the introduction of lengthwise layers of steel wire surrounding the barrel between layers of the wrapping wire, and in Schultz's gun the breech is bound to the trunnion-ring by round bars of steel.

It is claimed by the representatives of cast-iron in this country that it has never been tested using the slower-burning and large-sized grained powders now in vogue. Guns, made of any material, should evidently be so constructed in dimensions and chambering as to cope in power and effectiveness with their rivals, caliber for caliber. In order to do this, large charges would necessarily have to be employed with cast-iron, and however judiciously air-spacing and chambering may be done, and even using the most perfect powders, the pressures resulting from the large masses consumed would rise beyond what is ordinarily deemed a safe pressure (17.1 tons per square inch), even for guns using steel and iron. To illustrate: The two Armstrong 10.236-inch wire guns have been fired 60 rounds, and the pressures have been 67,000 pounds per square inch. This is not deemed by authorities on these matters as safe for any of the ordinary constructions now in use, and cannot hence be regarded as by any means a safe one for cast-iron, however thick the walls are made within the limits of reasonableness of weight, and hence, although its use might have been entertained as possibly a safe structure some time since, when large charges in stronger gun-constructions did not obtain, the conclusion has now to be drawn that no good reasons, even on the grounds of insufficiency of trial, exist for the further test of the metal which, owing to high pressures, will be unable to cope in power, gun for gun, with stronger systems susceptible of enduring the enormous strains arising from heavy charges, and which are beyond the capacity of any cast-iron to withstand.

It is not understood that any important modifications are at present intended in the general features of the present constructions using wrought-iron exterior tubes, the change being confined principally to the substitution of the one metal for the other. The change has, however, so far progressed and been so well established as an improvement, that steel coils for 80-ton guns have already been produced at Woolwich, and applied in the more recent fabrication of these heavy pieces; the heaviest products, in fact, as yet turned out by the Royal Gun-factory. See *Armstrong Guns* and *Ordnance*.

GUN-COTTON.—The prevailing sentiment in military circles on the Continent is adverse to the use of this powerful explosive. This opinion is based on the belief that the substance is not a stable one, but is liable, under the ordinary circumstances attending its use for military purposes, to spontaneous combustion. A claim for reliable stability was set up for it in 1862 by Baron General von Lenk, who contended that gun-cotton when carefully prepared and thoroughly cleansed from all remaining free acid is as stable a compound as gunpowder; but the subsequent explosion in Austria of a magazine in which both gunpowder and gun-cotton were stored did not fail to excite suspicions against the latter as being in some way implicated in the explosion, which could not be otherwise satisfactorily explained, to turn the tide of public opinion against the new compound, and confirm the doubts which had previously existed, whether it possessed in a sufficient degree the quality of stability, without which it could not be trusted. The experiments commenced in 1863 by direction of the English Government to test thoroughly, upon a large scale, the question whether gun cotton, prepared after the process of General Lenk, possessed the required stability to warrant a sure confidence in its remaining indefinitely in an unchanged condition when subjected to all of the changes of temperature that it would meet with in actual service, have been so entirely satisfactory as to lead to its general use for destructive effects in mines, torpedoes, etc. In order to remove all trace of free acid from the gun-cotton, which is an absolute essential in all cases, the process of General von Lenk required long-continued washings in running water, sometimes extending over several weeks, to accomplish thoroughly this prime requisite. The capillary action of the long fibers of the cotton formed a great barrier to the ready and complete removal of the acid, and consequently the operation of washing was a long, tedious, inconvenient, and uncertain one. Professor Abel, the Chemist of the War Department, to whom was committed the chemical and manufacturing part of the investigations, made several important improvements in the process of manufacture, chief of which is the reduction of the gun-cotton to a state of pulp. This, though originally adopted for another purpose, has much improved its quality, especially in regard to stability, which has been greatly assured by the more thorough and complete means of getting rid of the free acid, while the long washings in running water have been avoided, and the time required for the whole process of manufacture reduced from three or four weeks to as many days. The terrific accident which occurred at Messrs. Prentiss's works at Stowmarket in 1871, where gun-cotton was being manufactured for the Government, and when 13½ tons were exploded, would have destroyed all confidence in its stability and caused its use for military purposes to be discarded forever after; but it was conclusively shown, after a thorough and searching examination into the causes of the accident, that the explosion did not result from spontaneous combustion of the gun-cotton as it came from the last operations of the manufacture, but was caused by impure gun-cotton, rendered so by acids which had been poured on it willfully by some unknown persons after it had passed through the finishing processes. The evidence taken at the examination is conclusive, and the experiments made in England, on which this evidence was based, go to inspire entire confidence in the stability of gun-cotton when it has been carefully prepared. Samples which have been subjected for eleven years or more to every degree and change of temperature that would be encountered in actual service in any known climate show no appearance of change, but remain in exactly the same state as when first made.

Experience has shown that in the manufacture of gun-cotton it is a matter of the greatest importance for the success of the process and the reliability of the product that the manufacture should be conducted with the greatest care and circumspection; and to secure this it is desirable that it be in the hands of responsible persons who have no interest in slighting any part of the work. Impressed with the importance of adhering closely to the minutest detail in the different operations, the necessity for which was brought out clearly in the investigation above referred to, the English Government determined to establish a gun-cotton factory under the immediate supervision of army officers, and accordingly one was established at Waltham Abbey, under the direction of the Superintendent of the gunpowder-mills. In all of the various stages of manufacture the gun-cotton is in a wet state, entirely harmless, and the manipulations unattended with danger. It is not necessary, therefore, that the buildings should be removed at a great distance from each other, as in a gunpowder-factory, but, for the convenience of furnishing the necessary power to drive the machinery, the buildings, built of brick, are placed near together, like ordinary shops, with a steame-engine for the motor. The material required by Von Lenk's process for making gun cotton was raw cotton of long staple and high quality; but Professor Abel prefers to all others the waste cuttings from spinning-machines, such as is used in workshops for cleaning machinery, for the reason that it has already undergone so thorough a cleansing in the process of spinning through which it has passed that it requires no further purification to prepare it, and the gun-cotton made from it is free from those impurities foreign to cellulose, which are removed from the raw cotton with so much difficulty, and are apt to form with the acids products of somewhat an indefinite and comparatively unstable nature, and become the initial points of any change or decomposition which might be started by long exposure to high temperatures. The points to be particularly attended to are to see that the waste is entirely free from impurities, such as portions of seed-husks and foreign substances, and is thoroughly dry. The waste is received in bales, the cotton in a rough tangle. It is first picked over by hand, to remove all impurities that can be thus culled out, and is then passed through a machine which, by means of toothed rollers, opens and loosens the cotton, and subjects it to the strong blast of a fan, which blows off other foreign matters. Raw cotton at ordinary temperatures absorbs from the atmosphere about 6 per cent of moisture. To remove this thoroughly the cotton-waste is subjected to a temperature of 126° for the space of 20 minutes. For this purpose a drying-chamber, long and narrow, is made of boiler-plate, covered over on all sides with a non-conductor, to keep in the heat, and for economy of labor and fuel is so arranged that its action shall be continuous and not require to be stopped to introduce or remove the cotton. It is heated by air which has just been in contact with coils of hot pipes, through which steam is kept circulating. The necessary ventilation is provided to carry off the moisture. It is provided with five horizontal endless belts running from one end of the chamber to the other, one above the other; to each of which is communicated a slow motion by the machinery, acting by means of belts on pulleys outside of the chamber, fixed to the same axles as those on which the endless belts move. The cotton is fed by hand into a trough in the picking-room, and passes thence to an endless belt, which conveys it to the upper belt in the drying-chamber. This belt carries it through the length of the chamber and deposits it on the next lower belt, which performs a corresponding service, and so on to the last, which leaves it in a close closet prepared for its reception. The cotton, now thoroughly dry and warm, is weighed out in parcels of 1½ pounds each; and, to prevent it from absorbing moisture from the air before it is used (it cannot be dipped in the acids until it has cooled), it is placed in tin boxes, with closely-fitting covers, and stored away until cool and ready for use. The acids are procured by contract from private manufacturers. It is particularly required that they should be in a highly concentrated state and of uniform specific gravity, the nitric acid 1.52 and the sulphuric acid 1.85. The presence of hyponitric acid in the former (from which, when concentrated, it is with difficulty eliminated) is not regarded as an objectionable impurity. The acids are thoroughly mixed together in the proportion of three of sulphuric to one of nitric, by putting a certain weight of nitric acid into one tank, and into another of equal height three times the weight of the sulphuric acid. These two tanks are provided with outlet-pipes which will empty both tanks at the same time. These outlets are brought together into a single pipe, which conducts the acids to a considerable distance into a third tank, in which there is a mixer, to which motion is communicated by means of a pulley on the outside. After the acids are well mixed together, they are forced into tanks above the dipping-room, where they remain well covered for a considerable time before being used—in all cases until their temperature, which was raised by mingling the acids together, has been reduced to that of the atmosphere.

The immersion of the cotton in the acids gives rise to active chemical action, that of the nitric acid upon the cotton, and this with the union of the acids with the liberated water causes the evolution of considerable heat which it is necessary to control and regulate. To carry off and keep down this heat, the vessels in which the cotton and acids are brought together are surrounded by cold water. A large deep trough extends along one side of the dipping-room, and a stream of running water is kept constantly passing through it. In this trough is placed a long row of tanks, each some 14 inches wide, 2½ feet long, and 16 inches deep. These are kept filled with a certain measure of acid, into which the 1½-pound charges of cotton are dipped. The partition-wall along the line of tanks has a row of holes cut in it, each large enough to pass a charge of cotton through it into the dipping-room. The holes are about 8 feet apart and are provided with close shutters, which are kept closed except when required for the delivery of cotton. Each workman is charged with three consecutive tanks, which he uses for dipping. He fills the first to a fixed height with the acids, raps on the shutter for a charge of cotton, which is passed by an attendant from the tin box in which it has been kept through the hole into a wooden scoop ready to receive it, from which the workman takes it and plunges it into the acid and leaves it there. He then proceeds to the second tank, and goes through the same operation, and afterward the third tank. By this time the cotton which was dipped first, having been in the acids a sufficiently long time, is taken out with a long iron fork and laid on an open grate at the back of the tank, where as much of the acid is removed as can be pressed from it with the fork, using it for this purpose as a lever, and engaging the end under a cross-bar placed in rear of the grate. The charge of cotton is then placed in an earthen jar, covered with an overhanging cover of the same material, and deposited in the soaking-room, where it remains for twenty-four hours standing in a basin of water. The cotton has absorbed and taken with it about eleven times its weight of acids. The workman replaces this amount with fresh acid, immerses another charge of cotton in it, leaves it, and proceeds to the next tank to go through with the same manipulations as at the first, and so on to the others, taking each in its regular order of succession and going through exactly the same motions. By this process of saturating the cotton in the acid the greater part of the former is converted into trinitro-cellulose, but there are generally some portions which escape, to a certain extent, this change; therefore, to insure the conversion of the entire mass, the cotton still containing an ample sufficiency of acids to continue the chemical action upon the fibers not yet acted upon is set away in earthen jars to give the necessary time to complete the change. A considerable amount of heat is still generated by this action, and, to carry it off and prevent its accumulation, the jars containing the dipped cotton are placed in cold water of a depth equal to three fourths their height. The soaking-room has its floor laid in concrete and cement, and is divided into several shallow basins, which will contain each about fifty jars, and are capable of being readily filled with water to a depth of 6 or 8 inches, and emptied at pleasure. The cotton is kept here for twenty-four hours, during which time especial pains must be taken to prevent in every way the addition of the least water to the cotton, as the result of such accident would be its ignition and entire consumption. In such cases strong nitrous-acid fumes are evolved, and the jar is removed to the open air, where the cotton is quietly consumed without other damage than its loss.

The next operation is to get rid of the free acid contained in the cotton. This is effected, first, by means of the centrifugal drying-machine, which is 30 inches in diameter and makes 1500 revolutions per minute. The contents of five or six jars are emptied into the centrifugal machine, and the charge is uniformly distributed before the machine is set in motion. When the acid ceases to drop from the cotton the latter is taken out of the machine, and a greater portion of the remaining acid is removed and the chemical action arrested by washing in fresh water. Care is to be taken at the first washing that the cotton is plunged quickly, in small quantities at a time, into a large body of fresh water, in order to avoid the danger of ignition. The first washing is performed in a large tub, in one end of which there is a wooden wheel which plunges the cotton, in small portions at a time, into the water, and submerges it at once. From this tub the cotton is taken to another centrifugal drying-machine, by which the water is removed, when it is again washed and dried in the same manner. The cotton is next carried to the pulping-machines to be reduced to pulp. These are essentially the same as the ordinary machines used for producing pulp for paper, and do their work in the same way. The pulp next runs into the poaching-machine, where all of the remaining free acid is removed by continuous washings in fresh water, and finally at the close in water made slightly alkaline. The poaching-machine is a large trough, 24 feet long, 12 feet wide, and about 5 feet deep, with a large wooden wheel, like an ordinary water-wheel, of 2½ feet width of face, placed in the middle of, and parallel to, the longer side of the trough. Pipes are provided for furnishing a continuous supply of pure warm water and carrying off the surplus, as well as for conducting the pulp to and from the trough. A rotary motion is communicated to the wheel, which stirs up and keeps the pulp in constant commotion, dragging it down at one end and forcing it out at the other, at the same time assisted by workmen who, with long wooden scrapers, push it forward where it will meet the action of the wheel, thus bringing every particle in contact with fresh water and washing it in the most effectual manner. This operation is continued uninterruptedly, the water being constantly changed, until samples of the cotton will sustain satisfactorily a severe heat-test; this generally requires about 48 hours, though it may require 100 hours. At least a half ton of gun-cotton is washed at one time in the poaching-machine, and by this means the products of many different dippings are most intimately mixed together, so that the greatest uniformity in the material is attained. Before being taken from the poaching-machine the gun-cotton is washed in water rendered slightly alkaline with the carbonate of lime and soda. It is desirable that the gun-cotton should contain as much as 3 per cent of these mineral substances. The manufacture is now completed, so far as relates to the giving of the cotton its explosive properties and its resistance to further change under the ordinary circumstances of service and use. Great care is required, even to the minutest detail of manufacture, to insure a product of uniform quality, and it is insisted upon that too much stress cannot be laid upon the fact that deviations from the prescribed process, which may appear at first sight trivial (such as a slight variation in the strength of the acids or the neglect of proper cooling arrangements), are certain to lead to varieties in the gun-cotton produced affecting its explosive character or its stability, or even both.

In order to control the explosive power of gun-cotton it is necessary to compress the pulp into homogeneous masses of required form and density. For mining purposes and for torpedoes it is formed into circular disks, 3 inches in diameter and 1.75 inch thick, of a density slightly greater than water at 60° F., between 1 and 1.003, and each disk has two holes bored through it about .2 inch in diameter. To form these disks the pulp is drawn from the poaching-machine into a large, close iron tank called the stuff-chest, which, for convenience of drawing off the pulp, is placed on a level above the machines used for pressing the disks. It is supported on iron columns about 9 feet high, and being also on a higher level than the poaching-machine the pulp has to be raised into the stuff-chest by first exhausting the air from it. It is provided with a wooden wheel, which, in revolving, keeps the pulp stirred up in constant motion and prevents it from settling and separating from the water in which it is held suspended. A pipe in the bottom of the stuff-chest conducts the pulp into the machine for forming the disks. This machine is constructed on the same principle and worked in the same manner as that used and described for pressing pellet-powder. The mold-plate in this case is a large bronze cylinder, about 15 inches long, and has 36 holes about 2½ inches in diameter bored through it. It is stationary, and made fast to the frame of the machine. A corresponding number of closely-fitting bronze plungers enters these holes from below and closes them at the bottom. These plungers are made securely fast at their lower end to a plate which is moved up and down by a hydraulic press, and are pierced with small holes running through them parallel to their axis. The object of these holes is to afford a way of escape to the water in the pulp when it is subjected to a heavy pressure. These plungers are first partially withdrawn a certain distance, so that the molds shall contain a certain fixed volume; the latter then are filled to the top with pulp from the stuff-chest, and are closed on top by means of an overhead block. The plungers are now forced upward by the pumps, and the pulp is compressed into a solid cake, the water escaping from it through the plungers. The overhead blocks are now removed, and, the plungers continuing their upward motion, force the gun-cotton out of the molds in shapes of short, compact cylinders. They are then carried to the next machine, which is similar to the first, except it has only four molds, 3 inches in diameter; in each of these three cylinders of gun cotton are placed, separated from each other by circular iron plates, the edges of which are cut obliquely, with shallow channels to permit the water in the cotton to find its way out. The pressure brought to bear on each plunger is 15 tons, and the short cylinders of gun-cotton are pressed into disks 3 inches in diameter, 1.75 inch thick, and weigh 9 ounces each. The gun-cotton still contains 20 per cent of moisture, and can be sawed or bored with perfect safety, or placed in the flame of a candle, or bored with a red-hot iron without danger. Each disk is bored with two holes about .2 inch in diameter, parallel to the axis, and disposed symmetrically on either side of it. Gun-cotton is packed in water-tight boxes, containing about 20 pounds each. As many disks are put in as the box will hold, which is then filled with water, and permitted to stand for some minutes, when it is poured off and the cover securely screwed down. It may be kept with entire safety in this condition for an indefinite period, and be transported without danger or fear of accident, in any conveyance, having in this respect the advantage over gunpowder or most other explosives. The discovery made by Professor Abel, that wet gun-cotton can be fired with the same effect as if it were dry, if there be present a small portion of the dry cotton, and it be exploded by a detonating fuse, is a most valuable one, inasmuch as it obviates the necessity of drying it, the only operation in the process of manufacture that is attended with any danger. Besides, it diminishes the liability to accidents in transportation and in use, as the damp cotton is perfectly uninflammable so long as it remains damp. It is necessary to dry only a disk or two for each separate mass to be exploded, and this may be done safely on hot plates which are freely open to the air at the sides. The factory at Waltham Abbey has the capacity to turn out 4000 pounds per day, and is usually making about 1500 pounds per day. The cost of manufacture is stated to be 42½ cents per pound. Experiments are being made to test its fitness for bursting-charges for shells and rocket-heads, for which purposes it is thought to possess advantages over gunpowder. See *Explosive Agents* and *Gunpowder*.

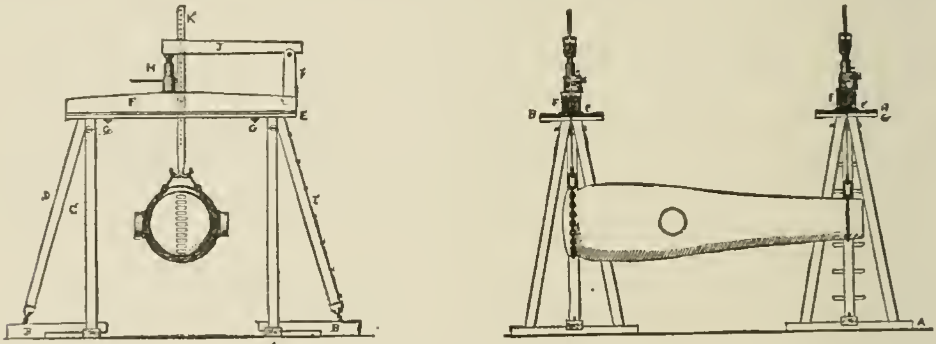
GUN-DETACHMENT.—The men employed in the service of artillery are called artillerymen, and those for a single piece constitute a *gun-detachment*, varying in number with the size and kind of piece. The gun-detachment is composed of two non-commissioned officers and from two to ten privates. The senior non-commissioned officer is called the Chief-of-detachment; the other, the gunner. The privates are called cannoneers.

GUN-FIRE.—The well-known name in the army, proclaiming the break and close of day by the firing of a gun; in the former case troops turn out and prepare for the forthcoming duties of the day, and in the latter all night-duties commence. See *Tattoo*.

GUN-LIFT.—A contrivance for moving, mounting, and dismounting heavy guns. It is variously constructed. The gun-lift generally employed in the United States service is shown in the drawing, and is described as follows: A is the *sill*, with mortises to receive the legs of the trestles; B, is the *brace-sill*, notched to fit on the sill, with a bolt and key to secure it in its place, and a cast-iron seat for the end of the adjusting-screw of the brace to rest in; C, the *legs* of the trestle, bolted and keyed together at the top; D, the *brace*, with adjusting-screws attached to the foot, and cleats to form a ladder; E, the *cap*, with a shallow mortise near each end to receive the ends of the legs and braces, and a hole to receive a large bolt for securing it to the legs. These bolts are keyed below, and their heads project above the cap about three inches, and serve as dowels to secure the bolsters; F, the *bolsters*, resting on the cap, having a clevis at the center of gravity for hoisting it in position, and mortise for the hoisting-bar to pass through; G, the *bracket*, fastened to the cap by a bolt, around which it turns; H, the *staging-plank*, resting on brackets; I, the *fulcrum*, resting in the mortise in the bolster; J, a *lever*, one end resting in the fulcrum and the other end on the hydraulic jack, and having a mortise through which the hoisting-bar passes; K, the *hoisting-bar*, with hooks on the lower end for sling-chains, and holes at intervals to receive the supporting-pins; L, *shears*, for hoisting into their places the bolster, levers, fulcrums, and jacks; M, *hydraulic jack*, for raising the end of the lever, and thereby the weight. Each gun-lift is provided with two sets of caps and bolsters. One of these sets has the mortises for the hoisting-bar through its middle; this is intended for center-pintle carriages. The other set has mortises much nearer one end than the other, and is for front-pintle carriages. The latter arrangement is intended to permit the carriage to be traversed from under the gun, when it is raised, or under it, when it is being mounted. When weights are not excessive—that is, not exceeding, say, fifteen tons—and can be slung with a single sling, but one trestle need be used. This would be the case with mortars, gun-carriages, and like weights. The jacks used must be of a power equal to the weight to be raised, as there is nothing gained for them by way of leverage.

Twelve men are necessary to erect the gun-lift and mount or dismount a 15-inch gun. The implements specially required are two *hydraulic jacks* (30-ton, or one 30-ton and one 15-ton), two *mauls*, two *hammers*, one *measuring-rod* (12 feet), one *spirit-level* (carpenter's). If the carriage and chassis are to be moved, quired, by turning the screw in the foot, until they shall have a good bearing when the legs are vertical, which is determined by a plumb-line or spirit-level. To raise the bolster a pair of light shears is provided. Place them so that when raised the head shall be over the middle of the cap of the trestle; hook the pulley-hook in the link provided for the purpose; fasten two guys to the head, one to the front and the other to the rear; raise the shears and make fast the guys; hook the pulley to the clevis of the bolster, and raise it to its place on the cap; raise the staging-plank and lay them on the brackets. Two men ascend the steps on the brace to the top of the trestle and receive the fulcrum, lever, and jack, which are hoisted to them in turn, and place them in position. The hoisting-bar is brought by the men on the ground, who insert it into the mortise in the cap and bolster, and raise it, assisted by those on the trestle, until it be in position.

To raise the weight, pass a sling around the weight, bringing the ends over the hook on the end of the hoisting-bar, taking in all of the slack. Bring the lever down on the head of the jack; put in the pin over it and through a hole in lifting-bar; commence pumping, and raise the weight the full lift of the jack; insert the pin in the hole in lifting-bar above the bolster and run down the head of the jack as far as it will go; bring the lever down as at first, and



Gun-lift.—United States Army.

the following will be required in addition: one *cradle* (or truck-wagon), six *cradle-rollers*, twelve *wheel-chocks*, four *way-planks*, two *shifting-planks*. A sufficient number of 44-inch blocks of various thicknesses should be at hand for any purpose required of such material.

To assemble and raise the gun-lift, place the sills parallel to each other at the required distance apart, and on the spot where the trestle is to stand. It will be convenient to have a wooden rod of a length equal to the proper distance between the sills. Lay down the brace-sills and key them; take two legs, bring together the two ends which form the miter-joint, pass the bolt through them, and drive in the key; raise one leg above the other, insert the head of the legs into the mortise in the cap, put in the bolt, and drive in the key. At the same time two other men have gone through the same operation with the other two legs. Place the ends of the legs that are on the ground close to the mortises in the sills; all take hold of the cap and raise it, bringing the trestle on its feet, and placing the legs in the mortises in the sills. A pole with a notch in the end, or hook like a boat-hook, will be convenient in raising the trestle after the cap is too high to hold it with the hands; or the trestle may be raised by the shears in the same way as the bolster, if the party be deficient in force, or if for other reasons it be deemed desirable. Correct the position of the trestle, if it be necessary, so as to bring the mortise for the hoisting-bar directly over the center of gravity of the weight to be raised. Put up the braces, varying their lengths as may be re-

continue this operation as already described. *The weight should not be left on the jack for any length of time, but on the pin.*

To mount a 15-inch gun with this gun-lift, bring the gun on to the platform by means of the cradle, or truck and portable railway, the muzzle to the front, the vent uppermost, and leave it in such a position, with the muzzle about two feet in the rear of where the end of the chassis will come, that when the gun shall be raised vertically the carriage can be placed on its pintle and directly under the gun; place the shears midway between the place where the two trestles are to stand; raise the trestles and place them over the gun so that one hoisting-bar shall be over the center of the neck of the cascabel, and the other about two feet from the muzzle; raise the gun to its full height as already described for raising a weight; remove the truck, bring the chassis (on a truck), and run it between the legs of the trestles under the gun; remove the truck and place the chassis on the pintle; bring the top-carriage and place it on the chassis, placing the trunnion-beds under the trunnions; lower the gun into its place, and remove the gun-lift.

If the gun and carriage be already on the platform, or if the peculiar position of the platform be such as to render the foregoing method impracticable, the following plan may be executed: Place the gun in such a position that the axis of the bore shall be in the same vertical plane as the central line of the chassis when the latter shall be in place; move the chassis parallel and close to the gun, the top-carriage run well to the front; put up the trestles over the gun and chassis, both of them being between the legs of the trestles; hoist the gun, raise and slide the chassis by means of the jacks under the gun and over its pintle; run the top-carriage back under the gun, and lower it into its place. See *Krupp Gun-lift* and *Prussian Gun-lift*.

GUN-MAKING.—Although the terms gunnery and gun relate chiefly to great-guns or cannon, the word *gun-making* is always applied to the manufacture of small-arms, comprising muskets, rifles, pistols, and carbines. In England the great seat of this trade was formerly London, whose workmen stood unrivaled throughout Europe for the excellence of their production; but of late years the gun-makers of Birmingham have succeeded, from local advantages, in turning out barrels of proved power, at such a price as to defy competition. Since then the London makers have confined themselves to "finishing," or putting together, an art requiring the utmost nicety; and even in this the skilled labor of Dublin and Edinburgh has now nearly equaled them. There are, therefore, several centers now in the United Kingdom whence first-rate arms are to be obtained. America and the leading Continental Nations are great manufacturers also, and each has its particular excellences. The chief Continental Gun-factories are at St. Etienne, Liege, Vienna, and Suhl.

Machinery has been comparatively slow in being applied to the manufacture of small-arms, but during the last few years it has made giant strides; and now the government manufactory at Enfield, in which numerous ingenious machines have been introduced from the United States, is fitted with every mechanical appliance, and can turn out many thousand arms per annum, each of which so exactly corresponds to pattern that all the constituent pieces are interchangeable. Barrels, instead of being forged by the hand-hammer, are rolled at once with a uniform pressure, and then welded at one heat. In the United States, barrels are at present made of cast steel, first formed in the solid, and then bored by a succession of borers of increasing diameter. These cast-steel barrels are rapidly superseding all others—at least for sporting purposes—in Great Britain, France, and America. Another favorite modern material for barrels is laminated steel. Barrels well constructed of laminated steel resist a bursting pressure of 82,000 lbs. on the square inch one eighth of an inch thick, whereas common "twist" barrels will only withstand about 34,000 lbs.

When the barrel is finished, however made, it is proofed, under very heavy charges of powder. All non-government barrels made in England must be proofed at the proofing-houses of London or Birmingham; government arms are tested at Enfield. The portions of the lock are made some of iron and some of steel, either forged by hand, or, as in the great manufactories, stamped out by a powerful machine. The stock is turned by machinery from strong light wood. On all accounts taken together, it is found that no wood is so well adapted as Italian walnut. The finishing or putting together of guns is an art in itself; the utmost attention having to be devoted to everything that will secure solidity, lightness, and the most minute accuracy of fitting. Skilled artificers in the gun-trade command excellent wages; rarely less than 40*s.*, and often as much as £4 per week.

In fitting and finishing, London is generally admitted to stand unequaled; Paris, however, making a good and near second. For barrels, Birmingham, St. Etienne, and Liege have the most repute. In all respects, Toledo, once famed for its blades, holds a high character in regard to its guns, both for sporting and military purposes. In the United States, Windsor and Hartford are the leading manufactories, with Springfield for government arms; but the quality of American workmanship is too often sacrificed to cheapness in the article turned out. The British export trade in small-arms is very great, the return for the year 1875 showing an exportation of 318,901 stand of all varieties, of the value of £655,169. See *Fabrication of Small-arms* and *Royal Gun-factories*.

GUN-METAL.—An alloy of nine parts of copper and one part of tin, used for brass cannon, etc. The term is also applied to certain strong mixtures of cast-iron. See *Bronze*.

GUNNELS.—A term sometimes applied to the *saddles* of a ponton-bridge. Commonly written *Gunwales*.

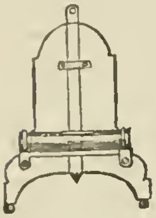
GUNNER.—A soldier, usually a non-commissioned officer ranking next to the Chief-of-detachment, employed to manage and discharge great-guns. In the United States service there is one gunner with each gun-detachment. In line, and in column of platoons, he is two yards in rear of the center of his detachment, except when belonging to the left detachment of the battery *in line*, or of platoon when in *column of platoons*,—in either of which cases he places himself on the left of the front rank of his detachment, and is the guide of that flank of the battery or platoon; in column of detachments, he is on a line with the front rank of his detachment, on the flank towards which the wheel was made, and one yard from it; in column of files, he is as if he had faced with his detachment from line. When he is the left guide of the battery or platoon, and by facing about the front becomes the rear rank, he does not quit his position on the flank of his detachment, but steps forward into the rear (now become the front) rank. When, by wheeling about, the right subdivision becomes the left, the gunner who was the left guide resumes his place in rear of his detachment, and the gunner of the detachment which has now become the left places himself on its left flank as guide of the battery or platoon.

In the British army, the gunner is a private soldier of the corps of artillery; he receives pay at the rate of 1*s.* 2½*d.* per diem. His uniform consists of blue with red facings, and red stripes on the trousers; and his arms consist of a carbine and sword-bayonet. At the present time, when artillery is used with the utmost skill and science, the training a gunner must undergo, to become thoroughly efficient, is long and arduous. His eye must be sufficiently acute to estimate distances instantly and approximately; and withal, he must possess physical strength capable of sustaining the exertions necessary for the service of heavy guns and the removal of shot and ponderous artillery stores. *Master-gunners* are pensioned Sergeants of artillery, who are placed in charge of the stores in small towers or forts; they are divided into three classes, of which those in the first class receive 5*s.*, in the second 3*s.* 6*d.*, and in the third 3*s.* a day. Master-gunners are now borne in the Coast Brigade of Royal Artillery, but the office has much degenerated in importance since it was first created, at least as far back as the time of Henry VIII.

GUNNER'S CALIPERS.—A small calipers made of sheet-brass, with steel points. The two branches are connected by a brass pivot, fastened on the upper side by a washer and screw. The branches are graduated so as to measure the lengths of fuses, the diameters of shot, and the calibers of guns. For measuring shot, the points are placed at the opposite extremities of a diameter, when the size of the shot is shown by the figures placed on a small arc on the circular part of the arm near the joint, the inner edge of the other arm, or a mark on it, coming in succession opposite the different points which mark the sizes. To measure the caliber of a gun, the position of the points is reversed; they are pressed against the sides of the bore at the extremities of a diameter, and the caliber is read off from the line, on a scale marked "guns," with which the back of the other branch coincides. The graduations on a scale next below the one marked "guns" will give the diameters in inches.

GUNNER'S GIMLET.—This implement is of the same form and size as the *priming-wire*, except that at the point a small screw is formed. It is used for boring out plugs which have been inserted in the vent, or the stems of the primers which may have become wedged in there.

GUNNER'S LEVEL.—An instrument for marking the line of metal on a piece. Until within a very recent period it was required with all pieces, but since the application of sights to guns its use is confined solely to mortars; and owing to the fact that these pieces are left rough and unturned on the exterior, the line of metal marked, in the usual manner, with a gunner's level and a chalk-line, is, at best, but a crude and imperfect method of obtaining a line of sight. The method of using this instrument is readily understood by an inspection of the drawing.



This instrument is frequently called the *gunner's perpendicular*.

GUNNER'S PENDULUM.—An upright frame of wood, having a cross-arm attached to it, from which a pendulum is suspended, vibrating seconds, consisting of a string with a leaden ball, measuring from the point of suspension to the center of gravity of the ball, a length equal to a second's pendulum having reference to the latitude; in latitude 22° the length is 39.1. It is employed to measure the time of flight of a mortar-shell.

GUNNER'S PINCERS.—When an obstruction in the vent projects beyond the surface of the gun, or has a head, it may be withdrawn with the *gunner's pincers*, which are made of iron with steel jaws, and have on the end of one of the arms a claw designed for drawing nails, etc.

GUNNER'S POUCH.—A leather pouch worn by the gunner, being attached to the person by a strap buckling around the waist. It contains the smaller implements required by the gunner when in action.

GUNNER'S QUADRANT.—An instrument for giving elevation or depression to a piece. It consists of a graduated quarter of a circle of sheet-brass, of six inches radius, attached to a straight brass bar twenty-two inches long. (Fig. 1). It has an arm carrying a

Fig. 1.

spirit-level at its middle, and a vernier and clamp-screw at its movable end. The arc is graduated to half-degrees, and the vernier reads to five minutes. To get a required elevation, the vernier is set at the indicated degree; the brass bar is next inserted in the bore parallel to the axis; the piece is then elevated or depressed until the level is horizontal. The elevation may likewise be obtained by applying the bar to the face of the piece, care being taken to have it in a plane parallel to the plane of fire. The latter is the mode of using it with mortars. The difficulty of applying the quadrant to the muzzle of guns, especially to those in embrasure, has suggested that a metallic ledge be attached to the end of a trunnion; upon this ledge the bar of the quadrant is applied when the elevation is to be given. The top of the ledge is parallel with the axis of the bore.

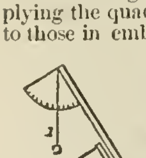


Fig. 2.

In another form, shown in Fig. 2, the quadrant is made of wood, and is attached to a rule two feet long. It has a *plumb-line* and *bob*, which are carried, when not in use, in a hole in the end of the rule covered by a brass plate. The quadrant is applied either by its longer branch to the face of the piece, or this branch is run into the bore parallel with the axis, and the elevating-screw turned or the quoin adjusted until the required degree is indicated. See *Mortar*.

GUNNERY.—Ignorance of the laws of gravity and of other physical circumstances affecting the flight of projectiles prevented any current theory of gunnery being arrived at in the earliest stages of artillery. The first author professedly treating on the flight of cannon-shot was Nicholas Tartaglia, a distinguished Italian Mathematician, who in 1537 published his work, *La Nuova Scientia*. He had no practical acquaintance with his subject, but his guesses were shrewd and often marvelously near the truth. Among other things he ascertained that no portion of the track described by a ball is a right line, and, as a practical aid to artillerists, he devised the gunner's *quadrant*. After Tartaglia, many philosophers, especially of Italy, theorized on the question, and various tables of ranges, elevations, charges, etc., had been published, all more or less fallacious, when a nearer approach to accuracy appeared in Galileo's *Dialogues on Motion*, printed in 1638. The officers who had charge of artillery in actual use were too little gifted with scientific education to deduce theory from practice; and up to the time of Robins, who wrote in 1742, but four working-gunners—Collado, Browne, Eldred, and Alderson, of whom the last three were Englishmen—have left treatises of any value on the use of their weapons. Galileo, in his contributions to physics, had shown that cannon-shot, or any other projectiles, being affected by the downward force of gravity, would travel in the curve of a parabola, unless affected by the resistance of the air. The philosopher pointed out modes by which the disturbances caused by this resisting medium might be ascertained; but subsequent writers, with the exception of Newton and Bernouilli, till the time of Robins, chose to assume that the atmospherical resistance was but nominal, and boldly asserted that all shot described parabolas in their course. In 1742, Mr. Benjamin Robins, who must be considered the real founder of the science, published his *New Principles of Gunnery*, a work the result of long and almost exhaustive experiments. He treated of the atmospheric resistance, of the force of gunpowder, of the effects of varying length and weight in guns, and of almost everything which in any way related to the motion of projectiles, carrying the theory of gunnery nearly to perfection. As one result of his experiments, Robins established the law that common shot encountered a resistance from the air during their passage, which increased as the square of the velocity, or very nearly so; and that their courses differed widely from parabolas. By means of the ballistic pendulum, he measured the speed of balls at the very cannon's mouth. Euler, in the latter part of the eighteenth century, added much to the knowledge of the subject by his commentaries on the work of Robins, as did also the mathematician Hutton.

The theory of gunnery, so far as it can be deduced from the universal laws of motion, without regard to the resistance of the air, falls under the more general head of projectiles. But except in firing bombs, which from their low velocity are not so much affected by the resistance of the air, the mere mathematical theory is of little service. All the real practical rules have been deduced from experiment. The following are a few of the more important results thus arrived at: For a given charge and weight of projectile there is a certain length of bore that gives the greatest velocity; the cause being, that with a less length some of the powder is discharged undecomposed, and with a greater the combustion is finished before the ball leaves the muzzle, so that it has to contend with the friction of the gun without receiving additional impulses. Increase of length, accompanied by proportionate increase of charge, gives increased velocity; but the greater velocity is only in proportion to the cube root of the increased length. The resistance of the air does not arise merely from the projectile having to displace its own bulk of it as it advances; for in the case of a body moving with great velocity the air becomes condensed in front of it, while that behind is highly rarefied. The displaced air behind does not return freely to fill up the vacuum, until the speed of the ball is reduced to 1400 feet per second; the maximum profitable velocity is calculated to be 1600 feet, and that, or any higher speed, is believed to be reduced to 1400 feet after a course of 400 feet. The resistance offered to bodies by the air is as their surfaces, i.e., in the case of round or cylindrical shot, as the squares of the diameters; whilst the power of the bodies themselves to overcome resistance is as their weights, or as the cubes of their diameters. Of course balls of like size but different density will produce widely different results. Hence the greater range of solid as compared to hollow shot. Solid shot fired with equal velocities and elevations range as their weight, the heavier overcoming atmospheric resistance better than the lighter. Shot of equal weight and diameter will range according to their velocities; but not in direct proportion, for the retarding power varies as the square of the velocity. Velocities of shot of equal diameter are as the square roots of the charges. The diminution in speed caused by atmospheric resistance may be judged of from the following table of the speed of a 32-pounder at different parts of its course; it being premised that a body in vacuo, once started, should move *ad infinitum*, without decrease of velocity:

	Feet per Second.
Initial velocity	1600
Velocity 500 yards from gun	1126
" 1000 " " "	1000
" 1500 " " "	608
" 2000 " " "	465
" 2500 " " "	367

Action and reaction being always equal and in opposite directions, the explosion of the gunpowder acts with equal force upon the ball and upon the cannon from which it is discharged, the former demonstrating this in its range, and the latter by its recoil. This recoil has to be guarded against as much as possible, either by the weight of the gun itself, or by its secure attachment to a ponderous carriage. The momentum of the recoil, being the product of the shot's weight, and the velocity, is readily calculated. The common charge of a 24-pounder gun being one third the weight of the shot, or 8 pounds, the momentum of both shot and gun will be 1600 (the initial velocity) $\times 24 = 38,400$, which divided by 5600, or the gun's weight in pounds, gives about 7 feet as the velocity per second; if the gun is attached to a carriage, the weight of the carriage must be added to that of the gun for a divisor. The foregoing table exhibits the effects of varying charge and elevation on different kinds of guns. The line of sight of a gun is an imaginary line drawn through the back-sight on the breech and the fore-sight, a notch in the muzzle-ring, or on the first reinforce. The fore-sight is immovable, but the back-sight is so constructed that the notch shall be at a greater or less height above the axis of the gun. When the line of sight is parallel to the axis and horizontal, the discharge is "point-blank;" but when the back-sight is raised, the direction of the axis of the gun will be to a point more elevated than that to which the line of sight is directed. Consequently, by raising the back-sight, a greater elevation, and, ordinarily, a greater range, is given to the piece. In regard to point-blank discharge, Tartaglia established the fundamental proposition that the time occupied by the ball in describing the whole trajectory or path is the same as it would require to fall by gravity from the muzzle to the ground. As regards penetration, it was found by experiments against a martello tower at Eastbourne, with a range of 1832 yards, that solid shot from the 40-pounder Armstrong penetrated into good masonry from 47 to 65 inches, and from an 80-pounder Armstrong 51 to 90 inches. See *Loading*, *Ordnance*, *Projectiles*, and *Windage*.

Nature.	Elevation.	Charge.	Range in Yards.
12-pounder iron gun.....	Point-blank,	4 lbs.	300
	1 degree,	"	700
	3 degrees,	"	1200
	6 "	"	1800
12-pounder Armstrong...	Point-blank,	1 lb. 8 oz.	330
	1 degree,	"	700
	3 degrees,	"	1425
	6 "	"	2440
	10 "	"	3590
32-pounder iron gun.....	Point-blank,	10 lbs.	390
	1 degree,	"	790
	3 degrees,	"	1500
	6 "	"	2220
	12 "	"	3060
40-pounder Armstrong...	Point-blank,	5 lbs.	360
	1 degree,	"	730
	3 degrees,	"	1455
	6 "	"	2505
	12 "	"	4470
68-pounder iron gun.....	Point-blank,	20 lbs.	400
	1 degree,	"	950
	3 degrees,	"	1715
	6 "	"	2465
	12 "	"	3400
110-pounder Armstrong..	Point-blank,	12 lbs.	345
	1 degree,	"	680
	3 degrees,	"	1335
	6 "	"	2280
	12 "	"	4035

GUNNY.—A coarse Indian fabric manufactured largely in Bengal. It is of two kinds for artillery purposes in that country, *single* and *double*; the former is used for charcoal-bags, for package of gunpowder-barrels, and as package generally; the latter for slings for carrying shot and shell, and small-arm ammunition-boxes, also for covering ammunition-boxes, making sand-bags, etc. The saleetahs and pin-bags for tents are also made of gunny. The material from which this article is manufactured is the fiber of two plants of the genus Corchorus, i.e., *Corchorus olitarius* and *Corchorus capsularis*; both, but particularly the first-named plant, are very extensively cultivated throughout Lower Bengal. This nature of cloth is universally used for bags of all sorts, and there is a very large exportation of this material to America, the Coromandel and Malabar coasts, and Singapore.

GUNNY-BAGS.—Bags made of coarse gunny-cloth, and used in India with siege-trains for carrying charcoal for the use of the artificers.

GUN OF RESERVE.—The name given to the old French 12-pounder. Its particulars were: bore, $4\frac{3}{4}$ inches; weight, 1350 pounds; charge, $2\frac{1}{5}$ pounds; weight of shell, $25\frac{3}{16}$ pounds.

GUN-PENDULUM.—An instrument invented for measuring the velocity of recoil and muzzle-velocities. It consists of a frame in which a light gun is suspended by means of a rod. The pendulum, of which the gun forms the *bob*, is capable of moving freely when the gun is fired. An arc graduated in degrees and minutes is attached to the frame, by means of which the angle of recoil is registered. Great care is necessary, in adjusting the weights, to get the center of percussion very nearly in the axis of the bore. The use of the gun-pendulum seems to have been suggested by Robins, although Count Rumford first reported, in 1781, the results of various experiments made with it for the determination of the initial velocity of projectiles, and the most advantageous position of the vent. The quantity of motion of the gun as a pendulum is equal to that of the projectile, charge of powder, and the air. From this the velocity of the projectile may be deduced. Extended experiments with both the ballistic and gun pendulums were made in England from 1775 to 1791, by Hutton; at Metz in 1839 and 1840; and in the United States from 1843 to 1848, by Major Mordecai of the Ordnance Department. See *Ballistic Pendulum*.

GUN-PITS.—Excavations made in the earth for the protection of artillery in the field, when a shelter is necessary. The guns may be often protected from the enemy's fire by natural banks, crests of hills, sand-mounds, etc.; but if there be no natural cover, resort must be had to the pickaxe and spade. A gun-pit can be excavated in one hour by experienced men. This gives but a limited space to the gun-detachment; so if there be time the pit can be lengthened, and the thickness of the parapet increased. Since isolated gun-pits, as explained in the first volume of *Instruction in Military Engineering*, would form good marks for the enemy's fire, it would be advisable to connect them by shelter-trenches, in which, however, places should be left to enable the guns to pass readily to the front. Should no natural cover whatever be available for the limber, cover for it and a pair of horses might be provided in a pit, somewhat of the form of a charger-pit, and similar arrangements should be made for the cover of more horses.

GUN-PORTION.—In fortification, half of the merlon on each side of the gun—that is to say, 9 feet on one side of the embrasure and 9 feet on the other.

GUNPOWDER.—Gunpowder is the agent employed in modern warfare to propel projectiles from all guns and small-arms, and generally as the bursting-charge of projectiles; for the explosion of mines; blasting purposes, etc. It is a mechanical mixture giving light, heat, and gas in the combustion or chemical union of its ingredients. Explosion is a phenomenon arising from the sudden enlargement of the volume of a body; as in the case of gunpowder, the solid body is rapidly converted into a gas many times its volume. If the body is confined in a limited space and exploded, great heat is developed and a vast expansion or propelling force produced, the volume of gas being very many times greater than that of the powder. In the United States service, gunpowder is obtained from private manufacturers. It is distinguished by granulation, irregular, as *musket*, *mortar*, *cannon*, and *mammoth*; regular, as *cubical*, and the *molded powders*, i.e., *pellet*, *hexagonal*, and *prismatic* (perforated hexagonal prisms). In all of these the proportions of the ingredients are the same; they differ only in the size and shape of grain, density and details of manufacture. Musket-powder is used for small-arms; mortar for field-guns; cannon for light siege-guns, and the larger-grained and special powders for heavy sea-coast guns. The materials required are *potassium nitrate* (*niter*), *charcoal*, and *sulphur*. They should be of the greatest possible purity to insure excellence of quality and guard against accidents in manufacture. The proportions by weight of the ingredients used in the United States service-powder are $\left\{ \begin{matrix} 75 \\ 76 \end{matrix} \right.$ niter, $\left\{ \begin{matrix} 15 \\ 14 \end{matrix} \right.$ charcoal, 10 sulphur. It is essential to the successful and uniform manufacture of powder that the ingredients should be procured in their rough state, and be refined and prepared for use at the factory; this is also necessary as a security against accidents at the mills. All foreign matter must be carefully excluded, and every precaution taken against their introduction in handling and moving the refined materials.

For the general purposes of artillery, slight variations in the proportions of the ingredients for powder are not found to affect its strength; but for blasting or mining purposes a slower powder is found to answer nearly as well as a quick one, consequently the proportion of niter is reduced much below that of gunpowder. Blasting-powder is thus made cheap; but as it leaves a large amount of residuum, it cannot be advantageously used in fire-arms. The several operations of fabricating gunpowder are: 1st. *Pulverizing;* which consists in reducing the ingredients to finely divided dust. 2d. *Incorporating;* which consists in bringing the particles of this dust into such intimate contact that each particle of powder shall be composed of one of each of the ingredients. 3d. *Compressing;* which gives strength and density to the substance of the powder, by converting the incorporated mixture into a cake which will not crumble in transportation. 4th. *Graining;* which breaks up the cake into small fragments or grains, and increases the surface of combustion. 5th. *Glazing;* which hardens the surface, to protect it from the action of moisture, and rounds the sharp angles of the grains to prevent the formation of dust in transportation. 6th. *Drying;* which frees the powder from the moisture introduced in certain operations of the fabrication. 7th. *Dusting;* which frees it from the dust, which would otherwise fill up the interstices and retard the inflammation of the charge. The proportions of the ingredients, as well as the art of making gunpowder, vary in different countries, and even among the different manufactories of the same country. The variations in the proportions are slight, however, and the differences in the modes of manufacture are principally confined to the more important operations of pulverizing, mixing, and compressing the composition.

The buildings in which the different operations are carried on are separated from each other, and protected by trees or traverses as far as practicable. The saltpeter is usually pulverized sufficiently when it comes from the refinery. The charcoal is placed in large cast-iron barrels with twice its weight of zinc balls. The barrel has several ledges on the interior, and is made to revolve from 20 to 25 times in a minute. It is pulverized in two or three hours. The sulphur is placed in barrels made of thick leather stretched over a wooden frame, with twice its weight of zinc balls from .3 to .5 inch in diameter, and the barrel made to revolve about 20 times per minute. It takes one hour to pulverize the sulphur. The ingredients having been weighed out in the proportions above given, the charcoal and sulphur are put together in a rolling-barrel similar to that in which the sulphur is pulverized, and rolled for one hour. The saltpeter is then added, and rolled for three hours longer. In some mills this operation is omitted. It is now taken to the cylinder, or *rolling-mill*. This consists of two cast-iron cylinders rolling round a horizontal axis in a circular trough of about four feet diameter, with a cast-iron bottom. The cylinders are six feet in diameter, 18 inches thick on the face, and weigh about eight tons each. They are followed by a wooden scraper, which keeps the composition in the center of the trough. A charge of 75 pounds in some mills, and 150 pounds in others, is then spread in the trough of the rolling-mill, and moistened with two to three per cent of water, according to the hygrometric state of the atmosphere. It is rolled slowly at first, and afterward from eight to ten revolutions of the roller per minute, for one hour for 50 pounds, and three hours for 150 pounds of composition. A little water is added, as the process advances, if the composition gets very dry—which is made known by its color. When the materials are thoroughly incorporated, the cake is of a uniform, lively, grayish, dark color. In this state it is called *mill-cake*. The quality of the powder depends much on the thorough incorporation of the materials, and burns more rapidly as this operation is more thoroughly performed.

The mill-cake is next taken to the press-house, to be pressed into a hard cake, is sprinkled with about three per cent of water, and arranged in a series of layers about four inches thick, separated by brass plates. A powerful pressure is brought to bear on the layers, which are subjected to the maximum pressure for about 10 to 15 minutes, when it is removed. Each layer is thus formed into a hard cake about an inch thick. The press-cake must now be converted into the particular size of grain required. And the means employed to break up the press-cake must be so arranged as to crush it up as nearly as possible into the size or sizes of grain wanted, without reducing much of it to dust. The smaller the size of grain, the larger will be the percentage of it obtained from granulated press-cake; hence with the small size of grain formerly used with cannon, any of the older and ruder appliances for effecting granulation gave good percentage of grain. But as recent experiments have conclusively proved that much larger-sized grains should be employed in the larger charges for heavy ordnance, new and improved granulating-machines have been introduced.

The granulated powder as it comes from the machine contains amongst it a large quantity of dust. This is formed by the crushing action of the granulating-machine, and must of course pass through the various sieves and screens with which the machine is provided along with the grain. The grain itself is not in a condition to be made use of as powder, being rough and porous on the surface and very angular in shape; and moreover, the presence of a large quantity of fine dust amongst it would render it not only most inconvenient to handle, but would also render it more liable to absorb moisture, and to deteriorate. A rough, unpolished angular grain would also very speedily rub down into dust, if subjected to much shaking in transport. It becomes necessary, therefore, to free the granulated powder from all traces of dust, and to polish or give a surface to the grains themselves to enable them to bear a great deal of friction without deterioration. Powder is freed from dust by placing it in revolving reels covered with cloth or wire-mesh of various degrees of fineness, through which the dust escapes. It is *glazed* by causing the grains to rub against each other in revolving wooden barrels. The extent to which the operations of dusting and glazing are carried, and the nature of the appliances used, depend entirely on the density, hardness, and size of grain of the powder operated on. Large-grained, dense, hard powder will bear a great deal of knocking about in the reels without becoming disintegrated and forming fresh dust; and will, moreover, bear a great deal of friction in the glazing-barrels, acquiring speedily a high degree of polish. But when operating on a small-grained, soft powder of low density, the dusting must be carefully conducted, as the process will develop as much fresh dust as it removes; and the amount of friction the grains will bear in glazing must be likewise carefully regulated. It is found in practice that powder may be divided into two general classes, each of which requires different treatment in dusting and glazing, viz., the *cannon-powder* of all classes and the *small-arm powder* of all classes. The former is not only pressed to a higher density, but is made of a larger size of grain; the latter generally is of lower density and much smaller size. Modern cannon-powder, being of large-sized grains and of firm consistency, admits of a comparatively open-meshed reel-covering being used in dusting, and of the process being continued as long as required without risk of injury to the grain. The powder can therefore be rendered perfectly free from dust, and sufficiently glazed at the same time, coming out of the reel as finished powder at one operation. Glazing, although of marked advantage to the finer classes of powder, is believed to be highly injurious to varieties approaching mammoth in size, for the reason that through the action of wearing away at one point and building up at another the powder becomes an assemblage made up of nuclei of about the density sought, incased in envelopes of dust, deposited during the period of glazing, and of very materially lower specific gravity than the rest of the mass, although the average or apparent density may be as desired; this causes extreme rapidity of combustion in the outer strata during the first instants of burning, followed by a less rapid development of gas from equal surfaces of the denser center toward the end of that period.

Before powder for the military service is received from the manufacturer, it is inspected and proved. For this purpose at least fifty barrels are thoroughly mixed together. One barrel of this is proved by firing three rounds from a musket, with service-charge, if it be musket-powder; if cannon- or mammoth-powder, from an 8-inch columbiad, with 10 lbs. and a solid shot of 65 lbs. weight and 7.88 inches in diameter; if it be mortar-powder, from a 3-inch rifle-gun, with a charge of 1 lb. of powder and an expanding projectile weighing 10 lbs. The general character of the grain, and its freedom from dust, are noted. Gunpowder should be of an even-sized grain, angular, and irregular in form, without sharp corners, and very hard. When new it should leave no trace of dust when poured on the back of the hand, and when flashed in quantities of ten grains on a copper plate it should leave no bead or foulness. It should give the required initial velocity to the ball, and not more than the maximum pressure on the gun, and should absorb but little moisture from the air. There are five kinds of powder in the United States land-service, depending on the size of the grain, viz.: *mammoth* for the 15-inch gun, *cannon* for smaller sea-coast guns and mortars, *mortar* for field- and siege-cannon, *musket* for rifle-muskets, and *rifle* for pistols.

The size of the grain is tested by standard sieves, made of sheet-brass pierced with round holes. The diameters of the large and small holes are as follows, viz.: for mammoth, .9 inch and .6 inch; for cannon, .31 inch and .27 inch; for mortar, .1 inch and .07 inch; for musket, .06 inch and .035 inch. Not more than 5 per cent. should remain upon the large nor pass through the small standard sieves. The specific gravity of gunpowder must be not less than 1.75; and it is important that it should be determined with accuracy. Alcohol and water saturated with saltpeter have been used for this purpose; but they do not furnish accurate results. Mercury, only, is to be relied upon.

Government powder is packed in barrels of 100 lbs. each. The barrels are made of well-seasoned white oak; and hooped with hickory or cedar hoops, which should be deprived of their bark to render them less liable to be attacked by worms. Barrels made of corrugated tin are undergoing trial, to test their fitness to replace those made of wood. Each barrel is marked on both heads (in white oil-colors, the head painted black), with the number of the barrel, the name of the manufacturer, year of fabrication, and the kind of powder,—*cannon* (used for heavy cannon), *mortar* (used for mortars and field-cannon), or *musket*,—the mean initial velocity, and the pressure per square inch on the pressure-piston. Each time the powder is proved, the initial velocity is marked below the former proofs, and the date of the trial opposite it. In the powder-magazines, the barrels are generally placed on their sides, three tiers high, or four tiers if necessary; small skids should be placed on the floor, and between the several tiers of barrels, in order to steady them; and chocks should be placed at intervals on the lower skids, to prevent the rolling of the barrels. The powder should be separated according to its kind, the place and date of fabrication, and the proof-range. Fixed ammunition, especially for cannon, should not be put in the same magazine with powder in barrels, if it can be avoided. Besides being recorded in the magazine-book, each parcel of powder should be inscribed on a ticket attached to the pile, showing the entries and the issue.

For the preservation of the powder, and of the floors and lining of the magazine, it is of the greatest importance to preserve unobstructed the circulation of the air, under the flooring as well as above. The magazine should be opened and aired in clear, dry weather, when the air outside is colder than that inside the magazine; the ventilators must be kept free: no shrubbery or trees should be allowed to grow so near as to protect the building from the sun. The moisture of a magazine may be absorbed by chloride of calcium, suspended in an open box under the arch, and renewed from time to time; quick-lime, as before observed, is dangerous. The sentinel or guard at a magazine, when it is open, should have no fire-arms; and every one who enters the magazine should take off his shoes, or put socks over them; no sword or cane, or anything which might occasion sparks, should be carried in. Barrels of powder should not be rolled for transportation; they should be carried in hand-barrows, or slings made of rope or leather. In moving powder in the magazine, a cloth or carpet should be spread; all implements used there should be of wood or copper; and the barrels should never be repaired in the magazine. When it is necessary to roll the powder, for its better preservation and to prevent its caking, this should be done with a small quantity at a time, on boards in the magazine yard. In wagons, barrels of powder must be packed in straw, secured in such a manner as not to rub against each other, and the load covered with thick canvas.

The recognition of the fact that different guns require for their most efficient service different powders marks an important epoch in the history of gunpowder. Previous to this time powder was the same, whether it was to be fired in a 6-pounder or 10-inch gun; and though experience showed that the large gun did not resist the strain of the discharge as well as small ones, the difference in their endurance was attributed to other causes than the want of adaptation of the powder to the gun. It was not suspected that the trouble arose from the unsuitableness of the powder. It soon became a recognized fact that the combustion of gunpowder was influenced to a great degree by the size, the shape, and the density of the grain; and as the weight of the projectile to be started became greater, so much greater became the necessity of regulating these particulars in the powder to be used. The improvements which have been made by attention to these particulars have rendered it practicable to use larger guns and heavier projectiles than had been deemed only a few years before to be within the limits of possibility. The point to be attended to is to see that the evolution of gas at the first moment of inflammation is not excessive, and this is effected by reducing the surface of ignition, that is, by increasing the size of the grains. Further, the evolution of gas should be gradual and progressive, and this is accomplished by giving the grain such a density that the hot gas shall not be forced by the pressure through the mass of the grain. The shape of the grain is also a matter of much importance, as influencing the progressive evolution of the gas. That shape of grain must be best which, other things being equal, has at first a small burning-surface and one that is continually increasing; or, this being deemed impracticable, the grain which approximates nearest this ideal must be best. The prismatic-shaped grain, with perforations running through it parallel to the axis of the prism, is to be preferred to all others that have yet been proposed. If it has not thus far given better results than others, it is because the practical difficulties in the manufacture are such as have not yet been overcome satisfactorily; but it by no means follows that they are such as may not, by future improvements, be surmounted.

It is an established fact that the quality of powder made from day to day will vary with the hygrometric state of the atmosphere, and it is almost impossible to make, at different times, two lots of powder which shall be the same in quality. The ingredients, if incorporated with a certain amount of moisture, will produce a different powder from the same materials mixed with a different quantity. Notwithstanding this fact, no efforts have been made to eliminate this source of variation, as it is believed might be done by keeping the air of the incorporating-mill constantly charged at all times with moisture. An important step has been made, however, to avoid this cause of difference more completely in a different way, and that is by the entire exclusion of water in all of the processes of fabrication. The improvement comes from Russia, as did the machine for making the prismatic powder. The materials, after being pulverized and thoroughly incorporated in tumbling-barrels, are raised in temperature up to the melting-point of sulphur at the same time that they are compressed into a cake. They are then cooled while under this pressure. The press-cake is broken into grains and glazed in the usual way. The charcoal has absorbed no moisture, and, as was to be expected, the powder has been proved to be stronger, and, it is said, more uniform in quality than ordinary powder. Should this process develop unknown difficulties and come short of the expectations that have been raised by it, nevertheless it will most likely exercise a beneficial influence on the mode of manufacture by stimulating and directing investigations in a direction that will probably lead to important results in the end. Gunpowder fails in too many respects to come up to the ideal of what the projectile-compound of the present time should be to retain its place much longer, unless marked changes shall be soon made in some of its properties.

English gunpowder has been long held in deservedly high estimation for its strength or explosive force, a quality which has been obtained for it by the exercise of great care in the selection of the best materials, and by the close attention paid to every detail of their preparation and thorough and complete incorporation. The greatest improvements have been made in the quality of the powder since the time when, instead of procuring the supplies required for the military and naval services by contracts with private parties, the Government became the owner of a powder-mill, and the manufacturer of its own powder, or a part of it, the different processes of fabrication being carried on under the immediate direction and supervision of its own agents. This mill is not of sufficient capacity to supply all, or anything like it, of the powder that is required in times of war; but, besides being of the greatest use in keeping up the high standard of the quality of powder (samples of standard powder are furnished annually to all powder-makers of the Kingdom), it is also of value in keeping down the price when supplies have to be procured from private manufacturers. The Royal Gunpowder-factory at Waltham Abbey is situated very near the old church from which it takes its name, about twelve miles from London, on the Eastern Counties Railway. The grounds are the rich meadows on the river Lea, which stream connects the canals between the different mills with the Thames, and furnishes water-transportation to Purfleet, where the powder is stored in large magazines. A portion of the grounds is planted with willows, set out with great order and neatness, the wood to be used for making charcoal for powder. The buildings in which the different processes of fabrication are carried on are scattered over upward of fifty acres, and built with special reference to the purposes for which they are intended. The niter and sulphur used are procured in the crude state and refined at the factory. This course is pursued in preference to purchasing them already refined, with a view of insuring uniform results in the powder manufactured, and of guarding more effectually against accidents, so much to be dreaded, from the presence of certain foreign particles in the materials, introduced among them before they reach the mills.

The grough saltpeter of India is purchased to the exclusion of all others. The process of refining is the usual one, and has in it nothing calling for remark. The water used is from an artesian well, and is remarkably pure and free from all mineral substances. The sulphur is procured from Sicily, and contains from 3 to 4 per cent of earthy matter, from which it is purified by distillation. It is ground under a small pair of wheels, when it is ready for mixing. Willow and alder are the woods used for making charcoal for all powders except musket. For this latter the alder buckthorn, or the berry-bearing alder (*Rhamnus frangula*), commonly known as the black dog-wood among powder-makers, is exclusively used. All of these woods grow in different parts of England, and efforts have been made to cultivate them on the grounds of the powder-mill, with success as regards the first two, but not the last, which requires a poor and rocky soil instead of a rich meadow-land for its growth. Large quantities of the dogwood are stored away for future use at the factory; the sticks, of about one inch in diameter, all brought from Prussia, at a cost of from $60 to $75 per ton. The difference between this and all of the other woods commonly regarded as best adapted for making powder is most marked, all of the others being light, brittle woods of rapid growth, whereas this is a dense, tough wood of slow growth, requiring usually ten years to attain a size of one inch in diameter. The charcoal is prepared by distillation in cast-iron retorts of cylindrical shape, set in brick-work, with flues to conduct the flame all round them. The gaseous matter and tar evolved in the distillation is conducted by pipes into the fire, and, besides economizing fuel in preparing the charcoal, furnishes the readiest means, by the color with which they burn, of determining when the charcoal has been carried to the proper point.

For convenience in handling, the wood is first put in sheet-iron cylinders, which are placed in the retorts. The retorts being thoroughly heated, the operation of charring requires from 2½ to 3½ hours. As the quality of the powder depends greatly on the temperature at which the charcoal is prepared, great care is taken to have this temperature constant and sufficiently high, but not too high. This is indicated by the color and fracture of the coal, which should be a jet black, with a clear velvet-like look when freshly broken. Analysis confirms the practical experience of powder-makers, that dogwood-charcoal makes a stronger powder than coal of any other wood, containing as it does a greater amount of gaseous constituents. The charcoal is ground in a mill resembling an ordinary coffee-mill, and is sifted by passing it into a cylindrical frame covered with iron-wire cloth, 32 meshes to the inch, and having a rotary motion around its longer and horizontal axis. The proportions of these ingredients are the same as those used in this country. They are weighed out in the proper proportions for a 50-pound charge, the saltpeter containing from 3 to 6 per cent of moisture, and are mixed together in the mixing-machine. This consists of a hollow bronze drum, which makes 40 revolutions per minute. A shaft passes through the axis of the drum, having a large number of arms made fast to it. The shaft and arms revolve in the opposite direction to the drum, and at twice its speed, thus mixing the ingredients together. The thorough incorporation of the materials is effected under heavy cast-iron or stone wheels, as in this country. The wheels are of various sizes, some as large as 7 feet in diameter, and others only one half of this, the preference being given to the smaller, as they are not so apt to cause explosions. The weight varies from 3½ to 4 tons. The bed is about 7 feet in diameter. There are in all 32 pairs of wheels for incorporating. A portion of them are driven by water-power, others by steam. The time required for the incorporation of a charge depends upon the kind of powder, the weight of the wheel used, and its velocity. Cannon-powder requires from 2½ to 3½ hours; musket-powder from 4 to 5½ hours. For the convenience of applying the motive power, the wheel-mills are placed in groups of four or six; and to prevent the explosion of one from extending to others of the same group, each is provided with a large vessel of water overhead, so arranged that an explosion of either mill of the group will overturn all of these vessels and pour the contents into the mill-bed beneath. This apparatus has been found to answer a good purpose, and has saved at different times a large amount of property.

Before being taken to the press-room to be pressed into cake, the mill-cake is passed through the breaking-down machine, which breaks up the lumps into a fine state of division to facilitate the operation of pressing. The breaking-down machine consists of a pair of gun-metal, cylindrical rollers, grooved longitudinally. They are placed side by side, their axes parallel and horizontal. The bearings of one roller are not fixed, but can be moved to or from the other, and are held in their proper position by means of a weight. The two rollers revolve in opposite directions, and the powder passing between them, the cakes and lumps are broken up into fine meal. A second set of rollers like those just described are placed directly under them, and break up any lumps that may have escaped the action of the first pair. The powder to be broken up is placed in a large hopper, from which it is carried to the rollers by an endless belt of strong canvas, which passes through an opening at the bottom of the hopper to the top of the machine, where it falls between the first pair of rollers.

The press used for pressing powder into thin cakes is operated by water pumped into a vertical cylinder. The press-box, in which the powder is placed, is 30 inches by 14 inches inside, made of great strength, of bronze, lined on the inside and outside with oak boards. Three sides of the box are hinged to the bottom, and when closed are secured by short, strong bronze screws. In order to charge the box the open top is temporarily covered with a piece of board, and the boxes turned over on one side. Bronze racks, with vertical grooves in them 1½ inches apart to hold the press-plates, are placed against two opposite sides, and the plates, 48 in number, slipped in. The spaces between the plates are filled with powder thrown in with a shovel, and the racks are then withdrawn, leaving the powder in layers 1½ inches thick, with a plate between the consecutive layers. The side which is now on top is screwed fast, and the box is turned over onto the table of the hydraulic press, bringing the press-plates horizontal. The board cover is removed, and the solid wooden block overhead, which resists the pressure of the ram, is adjusted so as to enter the box and be forced deeper and deeper into it as the powder is compacted. The pressure is applied by pumps driven by water-power in another building, between which and the press-house there are large earthen traverses. The inspection of powder is conducted with a strictness that would surprise our powder-makers. An inspection is required of the pressed cake after each pressing, and its density is determined with the mercury densimeter before it is permitted to pass on to the succeeding processes. The density of musket-powder is fixed about 1.725, and that of pebble-powder from 1.77 to 1.81, and R. L. G. 1.67. The finished product of each day's labor is inspected and proved. The size and shape of the grain are accurately determined. The proof of the different kinds of powder consists in determining the velocity imparted to a projectile fired from a gun under circumstances as nearly similar as possible to those of actual service. Musket-powder must give the service-ball a certain velocity when fired from the regulation musket; cannon-powder is in like manner proved by testing its strength when fired in the 12-pounder rifled gun; and pebble-powder when fired in a 9-inch or large gun.

In Russia all powder used in the military and naval services, as well as most of that for sporting and mining, is made under the direction of the Government at its own factories. Of private mills there are only a few small ones in Finland, where powder for sporting and mining purposes is made. The Government mills are three in number, and are situated in different parts of the Empire: 1. The Ohktenskoi mills, near St. Petersburg. 2. The Michael-Schosta, in Little Russia, in the saltpeter district. 3. That in the Kazan. Of these the second is the most extensive; the first is provided with the newest machinery and most improved appliances, and has a great capacity. The Ohktenskoi mills are situated on the Ohkta River, about six miles from St. Petersburg. They occupy about 1½ square miles of land, 230 acres of which, where the dangerous operations are performed, being inclosed by a high picket-fence on three sides, and the river on the fourth. The river furnishes the greater part of the power required for running the mills, but their number has been from time to time increased until the capacity of the stream has been exceeded, and now horses and steam have to be employed in addition to the water-power. The buildings are substantially constructed of brick on three sides, the fourth being of wood, so as to yield readily to any explosive force from within. The side selected for this purpose is that which is in the opposite direction from those buildings nearest to it. The buildings most recently erected, besides being built more solidly, are surrounded on three sides by an embankment of earth 15 feet high, 40 feet broad at the base, and 12 feet at the top. It has been found by experience that the vibrations resulting from an explosion are broken most effectually, and contiguous buildings are injured less when a body of water is interposed between them and the place of the explosion. For this reason a canal or pond of water is dug between the mills most liable to be exploded and the houses nearest to them. The grounds vary considerably in level, and the communication between the different mills is principally by means of wheelbarrows, very little by boat, and none by railway-trucks. The motive power furnished by the river is well applied. Just below the dam two large iron tubes 200 yards long and 4 feet in diameter, resting upon iron rollers raised on brick piers 6 feet above the surface of the ground, conduct each a stream of water to a series of eight water-wheels placed between a double row of wheel-mills, so that each water-wheel communicates motion to two mills. Some of these water-wheels are overshot, of 12 horse-power, and made of wood; but those most recently put in are of iron and of a peculiar construction. The water enters through a vertical pipe into the interior of the wheel to within about 2 feet of the bottom, and is then discharged from the curved surfaces which form the exterior. It is said to have a coefficient of .8. The rollers under the iron pipe are for the purpose of enabling it to accommodate itself readily to the changes in its length caused by the expansion and contraction due to the variations of temperature to which it is exposed; and this is considerable, between three and four inches.

The proportions of the materials used in the manufacture of gunpowder in Russia are the same as those used in this country and England. The saltpeter is obtained partly from Little Russia, where it occurs as a natural efflorescence on the ground, and may be much hastened by scraping the surface; and partly from the banks of the Volga, where there are found vast mounds, manure-heaps, which are now so many mines of saltpeter. So far from Russia being dependent upon any other country for this all-important material in times of war, she has within her own territory a larger supply than is necessary for her own wants, and is able to export some to Austria. Supplies required for the manufacture of gunpowder are furnished at the mills by contractors, already refined and ready for immediate use. The sulphur is obtained from Sicily in the state of roll-sulphur, which is further purified by distillation in the usual way. The charcoal was formerly made from the alder, but it is now made from a variety of the birch. Young trees as large as 5 or 6 inches in diameter are used. It is prepared in the usual way by distillation in iron cylinders in charges of 144 lbs. Fuel being abundant, no effort has been made to economize it by consuming the gaseous products of the distillation of the wood, as is done in England and Prussia. The charcoal and sulphur are pulverized together in a metal barrel 3½ feet long and the same in diameter. Three parts of charcoal and two parts of sulphur are put into the barrel with bronze balls ⅜ inch in diameter. The barrels are set in motion by horse-power, and made to revolve until the materials are reduced to a fine powder and thoroughly mixed together. The balls are separated from the mixture by means of a coarse sieve through which it is made to pass. One part of this composition is added to three parts of saltpeter, and the whole is thoroughly mixed together by hand on a table with raised sides and covered with a cotton cloth having holes in it to admit the arms of the workman. A little water is first added. This composition is next put, in charges of 120 lbs., under the wheels to be ground for four hours. The wheel-mills are of different construction, depending on the date at which they were put in. Those first used are of bronze, with bronze beds, about 4½ feet in diameter, and weigh about 3½ tons each. Those more recently put in are of iron, with iron beds about 7 feet in diameter, and weighing 4½ tons each. Some pairs of wheels revolve around an axis equidistant from the two wheels; in other mills the two wheels travel over tracks of unequal length. The results of a long experience show that there is no advantage to be had in making the wheels or bed of bronze; that such mills are no more exempt from explosions than the cast-iron mills, and in consequence the use of the costly material in future constructions is relinquished. The particular arrangement and disposition of the buildings for the incorporating-mills adopted at this establishment, by which they are placed in double parallel rows, with a water-wheel between each pair, the buildings being brought so close together, is most convenient and economical in supplying power to the different mills, but is highly objectionable in tending to render the explosions more destructive by increasing the chances of the explosion of one mill communicating to others.

The powder, as it leaves the incorporating-mills, or mill-cake, as it is termed, is broken into pieces by hand with wooden mallets and is passed to the press-house to be formed into cake. This is done by two different varieties of presses, the hydraulic and the Prussian press. The density of the Russian powder, like that of the Prussian, is very low, cannon-powder being .940, and musket from .920 to .935. The granulation of the powder is also performed in machines of quite different construction. One is the same as that used in Germany; the other consists of a long bed in which are arranged several series of sieves, each series consisting of four sieves, which are placed one over the other, the coarsest at the top. To this bed containing the sieves a quick horizontal reciprocating motion is communicated by machinery. The press-cake is placed in the upper sieve, and with it hardened lead balls about one inch in diameter. The balls now impinging against the cake, break it into pieces, the operation being continued until the pieces have been reduced in size so that they will pass through the meshes into the sieve beneath. The smaller pieces pass through the sieves until they have been assorted according to sizes of the meshes, the dust falling into a trough under the sieves. The contents of the sieves are put away arranged according to the size of the grain, and the dust found in the trough is taken back to be worked over. The glazing is done in the usual way by the friction of the grains against each other in revolving barrels. It is next dusted, and the grains are again assorted. The operation of dusting is different from that generally seen in other mills, though it is believed that its novelty is its only claim entitling it to notice. The machine consists of a horizontal wooden frame, with vertical guides to direct its motion up and down. On the under side of this frame there are pins driven in, from each of which is suspended by its closed end a long narrow bag of coarse linen cloth, something like a shirt-sleeve. The lower and open end of the bag is drawn aside from its vertical position, distended, and made fast to a wooden partition close by. Holes of the size of the mouth of the bag are cut into this partition where the bags are fastened to it, and are closed by snugly-fitting trap-doors which are secured from the outside. The powder is introduced into the bags through these holes until they are less than half full, and the holes closed; a vertical reciprocating motion is now communicated by machinery to the horizontal frame from which the bags are suspended, extending the bag each time its full length, bringing the closed end first above and then below the fixed end, and causing the powder to traverse back and forth from one end to the other and by its gentle motion to sift the dust through the cloth, when it falls to the floor beneath. Prismatic powder is made by compressing a given charge of soft grain-powder, which contains from 5 to 6 per cent of moisture, in a strong mold of the required size. The holes in the prism are formed at the same time the prism is made by means of small tapered spindles, which pass through the powder and the compressing-punches. The only machine that has been devised for the manufacture of this powder is the one designed by Professor Vichnegradski, and made in Russia, and since copied in Prussia and Holland. The idea of using powder compressed into a solid cake with parallel holes running through it forming surfaces of combustion which shall be continually increasing as the combustion continues was borrowed, as the Russians themselves frankly admit, from some experiments made first by Captain Rodman at Fort Monroe in 1861, and witnessed by a distinguished artillery officer of the Russian army. The idea was carried out successfully in a practical form first by the invention and operation of this machine, which is essentially one strong vertical punch carrying six punches, and forming six prisms or grains of powder at each revolution of the shaft or the descent of the punches. It is widely different in its general design and working from the machine made in England for pressing the grains of pellet-powder, as well as more successful and economical.

From the machine the prisms are next taken to the drying-house, where they are kept for a month; or, when the weather is good, they are dried in the open air, that is, in a building provided with numerous doors and windows which are kept open, but without the aid of artificial heat. Here they will dry in the course of five weeks. The density of prisms varies from 1.65 to 1.75, according to the gun in which it is to be used; the latter density is for the 11-inch gun. Prismatic powder is not glazed; it is said to resist the action of moisture better than ordinary powder. It is packed in boxes lined with paper, the prisms laid on their bases, close together, so they cannot move, and covered with felt. This kind of powder is not made at either of the other mills. In filling cartridges with prismatic powder, pains is taken to pack the prisms in the bag laid on their bases, fitting as closely as they can be packed, the holes in the prisms corresponding with those above and below, and forming air-passages for the communication of the flame through the whole length of the cartridge. The cartridge-bag is tied closely over the powder, fitting it snugly, and keeping the prisms in their places. Prismatic powder is used exclusively for all guns of a caliber of 8 inches and over. For 6-inch guns it is sometimes used, but not invariably, ordinary cannon-powder being also occasionally used, though less frequently than the prismatic. Ordinary cannon-powder is used for all field-guns and those of less caliber than 6 inches. All powder is proved by firing service-charges and determining the initial velocity of the ball. Ordinary cannon-powder is proved in a 4-pounder gun, the prismatic in an 8-inch gun. The pressure exerted on the bore of the gun by the prismatic powder is also determined.

Gunpowder for the Prussian military service is made part at the Royal Powder-mills of Spandau and Neisse, and part by private manufacturers in different parts of the Empire, the standard of quality being regulated by the former. The powder-works at Spandau are of very ancient date, a pounding-mill having been established here as early as the year 1344. They are situated on low ground on the banks of the Spree, in the midst of a wood only a short distance from the Arsenal on the opposite side of the river. The buildings, mainly of wood, are placed at considerable distances from each other, and the roads leading from one to another are covered with tan-bark to avoid the introduction of sand or gravel into the buildings, carried on the feet of the workmen. Water-power is the motor used to drive the machinery, with the exception of one steam-engine which drives the fan for forcing hot air into the drying-house some distance off, the boiler furnishing the means of heating the air. Few changes have been made in the manner of making powder within the last fifty years or more. The method of incorporating the materials known as the "revolutionary process," from its having been adopted during the war of the French Revolution, though given up by every other nation, has been adhered to with only slight modifications. By this method the materials are pulverized and incorporated by being rolled in barrels turning on horizontal axes, and containing besides a quantity of bronze balls of small size. The composition is pressed into cake by means of two rollers between which it is made to pass, being first evenly distributed on an endless band of coarse linen. The upper roller is of bronze, and its pressure on the lower roller is increased and regulated by a weighted lever. The woods used for making the charcoal are the berry-bearing alder and willow, which are cut into lengths of about one foot, from branches about an inch in diameter. The distillation is conducted in cylindrical iron retorts into which the wood is closely packed and then sealed. The retorts are provided with small wheels for the convenience of running them in and out of the furnaces.

After glazing, the powder is dried at a temperature of 190° F., being laid out for the purpose on thin canvas stretched over hot-water pipes, the hot air being forced up through the powder by means of a fan-blower. One hour and a half is sufficient to dry it. Its specific gravity is 1.64. The process of manufacture of prismatic powder was obtained by Prussia from Russia. The prisms are 1 inch thick, and the diameter of the circumscribing circle is 1.57 inch. There are seven holes, one in the center and the others opposite the angles, the center .32 inch distant from the angle. The holes are tapering from .185 inch to .165 inch. Specific gravity 1.66. A prism weighs 587 grains. They are packed in boxes of 110 pounds each. To prevent the prisms from breaking, a piece of felt .4 inch thick is placed on top of the prisms and at the end of the box. Prismatic powder is used in the 15-centimeter and all larger guns. The powder used by Krupp in all of his large guns is of the prismatic form, made at Hamm, by a private manufacturer, after the Russian system. The size of the prisms is the same as used by Russia and Prussia, the density varying with the caliber of the gun in which it is to be used. For the 12-inch and 14-inch guns the prisms are perforated each by only a single hole instead of seven, and that is in the center; it is .59 inch in diameter. The specific gravity is from 1.73 to 1.76. Important changes have been made in France during the last decade in the manufacture of gunpowder. The separate department for the management of the powder-mills and saltpeter-refineries has been abolished. The greater number of these establishments which were engaged in making sporting and mining powders has passed under the direction of the Minister of Finance; and five—Ripault, Bouchet, Saint Chamas, Angoulême, and Esquerdes—have been reserved for the manufacture of gunpowder for the Army and Navy. Since 1865, the date of this change, all experiments on cannon-powder have been carried on exclusively by officers detailed for the purpose. The powder-mill of Bouchet has been completely under the orders of the marine in making experimental powders for large guns. Numerous and different powders, varying in the proportions of the ingredients, the mode and time of mixing, the density, size, and shape of grain, have been made and sent to Gâvre or Ruelle, to be fired from guns of proper size, and the effects on the projectile and the gun carefully noted. Similar trials have been made with foreign powders, such as the English pellet, the Russian and Dutch prismatic, the Wetteren large-grain, and powders made like them, and their effects carefully compared.

Of all the powders experimented on, that which has given the best results in large guns is the large-grained powder made at the Royal Powder-mills of Wetteren, in Belgium. The pounding-mills, with their mortars and pestles, which have been so long used for incorporating the materials of gunpowder, have at last given place to the wheel-mill, in spite of the objections made to its use. It was found to be impossible to make powder suitable for the new material by this process, and a change has been also made in the proportions of the ingredients, and the formula used by most other nations has been adopted. France has acted to a greater extent than any other Power on the principle that every gun has its particular powder, which will do in this gun more work than any other, and has accordingly prescribed the size of grain for the powder to be used in each of the large calibers. The sizes adopted are, for the 14-centimeter gun, between .275 inch and .3937 inch; 19-and 24-centimeter gun, between .51 inch and .63 inch; 27-centimeter gun, between .63 inch and .787 inch. The Commanding Officer of the Bouchet powder-mill was charged with the duty of getting up a powder which should give as favorable results in large guns as that procured from Wetteren. Following the process suggested by Captain Castan, the effort was entirely successful, as was shown by the satisfactory report made on it by the Commission at Gâvre, where it was tested. The form given to the grain is that of a flat parallelopipedon, the thickness of which is the same as that of the pressed cake. A large-grain powder has also been made, suitable for the field-artillery, and another for siege-guns. The latter has grains .43 inch thick and a density of 1.79. It gives as high a velocity as the compressed rings previously used, with a less pressure on the bore of the gun.

Austria obtains her supply of powder partly from mills belonging to the Government, and partly from private contractors. Numerous experiments have been made with prismatic powder with the usual favorable results, but the expense of manufacture led to the search by experiment for a less costly powder which should meet the requirements of the service. In 1873 trials were made with a pebble-powder of an English make, and samples made at Stein, with grains of different sizes and density. The results showed the practicability of varying the grain in size and density so as to produce a powder which shall give in the gun for which it was intended sufficient ballistic effects with little fatigue to the gun. The experiments have not yet been concluded. Trials have been made with the Castan powder with good results. All of the dense powders thus far tried have given, with velocities equal to those given by the prismatic powder, considerably less strain on the gun. These powders have a specific gravity of 1.759 to 1.785. The proportions of the constituents used are 74, 10, 16, and the incorporation is effected by means of the wheel-mill. See *Absolute Force of Gunpowder, Breaking-down Machine, Charcoal, Compensating Powder, Cubical Powder, Densimeter, Drying store, Dusting-reels, Explosion, Explosive Agents, Glazing-machine, Granulating-machine, Gun-cotton, Hexagonal Powder, Incorporating-mill, Inspection of Powder, Magazine, Mammoth Powder, Mixing-machine, Nitrate of Soda, Nitro-glycerine, Packing of Powder, Pebble-powder, Pellet-powder, Powder-press, Preservation, Prismatic Powder, Progressive Powder, Round Powder, Saltpeter, Schaghticoke Powder, Schultze Powder, Sifting reel, Special Powders, Sphero-hexagonal Powder, Square Powder, Storage and Transportation of Powder, Sulphur, Wetteren Powder*, and *Wiener Powder*.

GUNPOWDER-BAGS.—Bags made of serge or other cloth, and used for blowing open gates, stockades, etc. The size of the bags differs according to the charge intended to be placed in them; they are fired generally by means of a Bickford fuse. The bags are either placed on the ground or fastened by a hook to the gate. In Burmah, in 1852, experiments were made to test the value of powder bags in blowing down stockades, and the result proved most satisfactory; bags containing about fifty pounds of powder causing a rent large enough to admit of a section of infantry entering within the inclosure. Experiments were also at the same time made with 8-inch howitzers, which failed to make much impression on this manner of defense. The Indian water-carriers' *mussuck* (water-bag), can be used as a powder-bag in any emergency.

GUNPOWDER FACTORY.—A series of buildings in which the several processes in the manufacture of gunpowder are carried out. A gunpowder-factory should be situated far away from inhabited localities. The buildings should be made of wood, so that in case of explosion the smallest resistance would be offered to the force of the powder. Explosions under any circumstances are disastrous, but if they occur in a masonry building are still more so. The generality of mill-houses, therefore, will be found to be made of wood, and protected from one another by huge banks of earth or thick masonry surrounding each house. There is no objection to making incorporating-houses of masonry if the walls are built thick enough to withstand the explosive force of a "mill-charge" (fifty pounds). To add to the safety of incorporating-houses, in case of an explosion in one room, the charges in the other rooms are by means of self-acting machinery instantaneously drowned in the water.

The principal, indeed the only, Government factory for the manufacture of gunpowder in England is at Waltham Abbey. All powder required in excess of what this factory is able to turn out is supplied by private factories on contract. In India there are three factories, one in each Presidency. See *Royal Gunpowder-factory*.

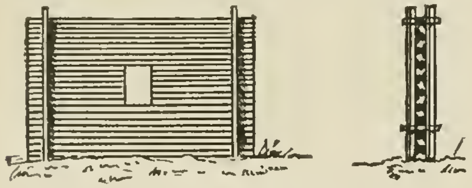
GUNPOWDER-HAMMER.—The pile-driver operated by the explosive force of gunpowder. Strong efforts have been made to bring this machine to successful operation, but in consequence of the great expense of working, the constant care, and the very accurate adjustment required, it has fallen into general disuse, especially for military purposes. The machine in its improved form may be described as follows: The leaders are built of iron and very carefully aligned. The "gun," shaped somewhat like a short field-piece, with wings on either side, and a recess at the breech, is fitted by means of grooves in the wings to slide easily between the leaders, the recess or cap receiving the head of the pile to be driven. When in position for driving a pile, the ram is suspended at the top of the leaders, held there by a trip operated by a line in the hands of a man on the deck of the machine. From the lower face of this suspended ram is a shaft turned to accurately fit the bore of the gun, whose upturned muzzle is expected to receive it. At a suitable height to accommodate the operator is an adjustable platform, which carries the operator and his supply of cartridges, containing each usually about three ounces of powder. When it is desired to drive a pile, the operator, standing on his platform, drops a cartridge into the muzzle of the "gun" and trips the suspended ram, whose projecting pintle, entering the muzzle of the "gun," by compressing the air generates the degree of heat necessary to explode the cartridge, the explosion of which throws up the hammer, and at the same time projects the pile into the ground. As the hammer or ram is thrown up, the alert operator drops in other cartridges, which are in turn exploded by the returning ram. As the pile settles into the ground, assistants keep the platform occupied by the operator in proper position; and when it is desired to stop the driving, enough cartridges are dropped into the gun to produce an explosion that will send the hammer clear to the top of the leaders, where it is caught and held ready for the next pile, which is brought into position in the usual manner and by the use of the ordinary machinery, which also twists the gun and lowers the same on to the head of the pile. In practice, to drive a 12-inch pile twenty feet into firm clay about two hundred blows would be struck, at an expense for powder of between three and four dollars. The gun is found to soon become foul, and creases are soon cut in it so that an escape of air causes the failure in exploding a charge: in which case a jamming of the pintle in the bore of the "gun" results, causing a great delay and no little expense. In Shaw's pile-driver, the monkey, or ram, is sustained at its highest elevation by means of a ratchet and pawl, while a cartridge and cap are placed in a recess in the head of the pile. The pawl being withdrawn, the monkey falls upon and explodes the cartridge. The force of the explosion raises the monkey to the height from which it fell, where it is automatically arrested by the detent arrangement. The effective force of the fall is said to be much increased by the action of the powder. One man places the cartridge in position and releases the ram. See *Pile-driver.*

GUNPOWDER-LAWS.—In order to guard against the frightful consequences to the public likely to arise from carelessness in the preparation, preservation, or conveyance of this most dangerous article, the English Legislature in 1875 made stringent rules upon the subject. By an Act which applies also to Scotland and Ireland it is provided that no gunpowder shall be manufactured except at a factory lawfully existing or licensed under the Act, and it shall not be kept except in the factory where it is made, or in a magazine or store duly licensed, or in registered premises. The license is obtained from the local authority (usually Justices), and approved by the Home Secretary. General rules are imposed for regulating factories and magazines. There must be a lightning-conductor. No charcoal nor oiled rags must be taken into the building except for immediate use. No smoking is allowed. Tools are to be made of wood or soft material. Workingmen's clothes are to be without pockets. Carriages and boats for conveying gunpowder must have in their interior no iron or steel exposed. Each building is to have affixed, so as to be easily read, the quantity of gunpowder allowed in each. Retail dealers must be registered, and must keep their powder in a separate house or in a fire-proof safe, not exceeding 200 lbs.; but if kept inside the dwelling-house, 50 lbs., or if in a safe inside, 100 lbs. The building or safe is to have no exposed iron or steel in the interior. A breach of precautions against fire or explosion is visited with heavy penalties. The local authorities must keep registers of licensed persons, and all rate-payers can demand a copy thereof. Retail dealers, if using less than 5 lbs. for cartridges at one time, are exempted from taking out a factory-license. No powder must be sold to a child under 13. All powder exceeding 1 lb. weight must be sold in a canister or case securely fitted, and with the word "gunpowder" visible. Also, powder must be closely and securely packed and labeled for conveyance, if exceeding 5 lbs., and the amount carried is not to exceed 100 lbs. All Railway and Canal Companies are to make rules and have special times and places for loading and unloading powder. Fire-work factories, if making and keeping less than 500 lbs of fire-works, need only a license from the local authority; but exceeding that quantity, one from the Home Secretary. To let off a fire-work in a street or highway subjects the offender to £5 penalty. A Government Inspector may at any hour of day or night enter and inspect any factory, magazine, or registered premises, and may require the occupier, under a heavy penalty, to make alterations or take certain precautions. Search-warrants are also readily granted, and in urgent cases are dispensed with.

GUNPOWDER MILL.—A machine used for mixing or incorporating the ingredients of which gunpowder is composed. The operation was formerly effected as follows: The ingredients being duly proportioned and put into the mortars of the mills, which are hollow pieces of wood, each capable of holding 20 pounds of paste, are incorporated by means of the pestle and spindle. There are 24 mortars in each mill, where are made each day 480 pounds of gunpowder, care being taken to sprinkle the ingredients in the mortars with water from time to time, lest they should take fire. The pestle is a piece of wood 10 feet high and 4½ inches broad, armed at the bottom with a round piece of metal. It weighs about 60 pounds. For more modern methods of incorporation, see the article *Gunpowder.*

GUNPOWDER PLOT.—A fanatical project on the part of a few Roman Catholics to destroy the King, Lords, and Commons on the meeting of Parliament on November the 5th, 1605. James I. had succeeded Elizabeth two years before, and his Government had exercised great severities against the Roman Catholics, not merely denying them religious toleration, but confiscating their property. A few ruined and exasperated men banded together to overthrow the Government. The originator of the plot was Robert Catesby, a man of fortune, which he had impaired by youthful extravagance, and who communicated his idea to Thomas Winter, who was horrified at first, but after a while began to approve and further it. For this end he enlisted into the conspiracy Guy Fawkes, a soldier of fortune, of considerable military experience, and a most determined and fearless character. Catesby enlisted other two, by name Wright and Percy—the latter a relation of the Earl of Northumberland. They hired a house and garden contiguous to the Parliament House, and commenced their mine, a part working when the others slept, and the rubbish being buried during night. One day they were alarmed by a noise after they had with much labor pierced the wall three yards thick. Fawkes learned that this noise proceeded from a cellar under the House of Lords, which would soon be vacant. He hired it, and barrels of gunpowder were placed in it, and stones and billets of wood placed over them, for the double purpose of concealment and to act as destructive missiles when the gunpowder was fired. In the interval, a brother of Wright and a brother of Winter had been added to the conspirators, so they were now seven. But they wanted money; and to supply it, two others were induced to enter this fanatical copartnery, and these were Sir Everard Digby of Gatehurst, in Buckinghamshire, a young gentleman of large estates; and Francis Tresham, a follower of Essex, like Catesby and Percy, but, unlike them, a selfish unenthusiastic man. Their plan was finally arranged for the reassembling of Parliament, which was to take place on the 5th of November. Guy Fawkes was to fire the mine (if the gunpowder in the cellar may be so called), and then flee to Flanders by a ship provided with Tresham's money, and waiting ready on the Thames. All the Roman Catholic Peers and others whom it was expedient to preserve were to be prevented from going to the Parliament House, by some pretended message or other, on the morning of that day. After all was ready, Lord Mounteagle was at supper at his country-house at Hoxton, where he very seldom was. As he sat, a page handed him a letter received from a stranger, advising him "to devise some excuse to shift off your attendance at this Parliament, for God and man hath concurred to punish the wickedness of this time." That this letter was written by or for Tresham, who was the Lord Mounteagle's brother-in-law, there can be little doubt. That he desired to save him was certainly one reason for writing it; that he desired to save the conspirators, or at least to allow them to escape, is very probable; and that they might have escaped, but for the fanatical hopes of Catesby, is all but certain. It is also probable that Lord Mounteagle had been fully informed of the whole matter by Tresham, and that the supper in the country and the letter were mere devices to conceal Tresham's treachery. When the letter was formally communicated to the King, he at once declared its meaning, and the most simple way of accounting for his power of divination is to suppose that, like Lord Mounteagle, he had been told beforehand. On the very evening of the 4th, the Lord Chamberlain and Lord Mounteagle visited the Parliament House, and entering the cellar in a casual way, told Guy Fawkes, whom they found there, and who passed as Percy's servant, that his master had laid in a plenty of fuel. Only fanaticism gone the length of fatuity could have made him persevere after this. But he did, though escape was still possible; and on the morning of the 5th, a little after midnight, he was arrested coming out of the cellar, dressed as for a journey. Three matches were found on him, a dark-lantern burning in a corner within, and a hogshead and thirty-six barrels of gunpowder. He was examined and tortured. He confessed his own guilt, but would not discover his associates. However, he and the chief of them were either killed on being captured, or died on the scaffold; except Tresham, who at first walked about openly, but at last was apprehended, and died of a natural disease in the Tower. The memory of this plot, invested by much fiction, has survived in England; and it was not more diabolical than hopeless and mad. It was in itself mysterious, and for purposes of state policy and Protestant zeal a further mystery was thrown over it. No name in English history has been more detested than that of Guy Fawkes.

GUN-SHELTERS.—During the third period of siege-operations the musketry-fire of the besiegers becomes very destructive to the artillerists of the defenses whilst serving the guns. Strong iron or oak musket-proof blinds should be arranged to mask the mouths of the embrasures when the guns are not in battery. Blinds, or covers of timber and of earth under which



guns can be secured from projectiles that would reach them at top or in flank, will now be serviceable. A few guns covered in this way, and placed in the salients of the collateral works, to obtain reverse views on the trenches constructed on the glacis of the works, will prove a serious annoyance to the sappers, and will greatly retard their progress. When railroad-iron can be obtained, shields, with embrasures in them, can be made as represented in the drawing. One thickness of iron is sufficient protection against projectiles from field-guns, two from siege-guns, and four from pieces of the 8-inch rifle class. The same material may be used for constructing field-casemates. See *Mantlet*.

GUN-SHOT.—The distance of the point-blank range of a cannon-shot. The distance to which shot can be thrown from a gun so as to be effective. The term *gun-reach* is used in the same sense.

GUN-SHOT WOUNDS.—These wounds may vary in severity from a simple bruise to the tearing away of a whole limb. Single balls produce a cut, bruised or lacerated wound, according to the amount of their velocity when they strike the body. The effects of small shot vary with the distance and power of the gun; when close, the charge enters with the pellets so close together as to make one wound like a single ball. Some years ago it was commonly believed that the "wind of a large shot" could produce serious injuries: this belief may have arisen from the circumstance that when a heavy ball, which has lost some of its force, strikes the body at a particular angle, the skin does not always give way, but the deeper structures, such as the muscles, or the large organs, as the liver, may be completely crushed. If the wind of a shot could kill a man, it is not likely that soldiers should have had ears, noses, and lips shot off and yet have experienced only the symptoms produced by those slight injuries.

When a bullet passes out of the body, there are two openings—that of "entrance," which is generally depressed, round, regular, and smaller than that of "exit." The modern conical ball makes a well-defined oblong wound, but it may shift its direction, so as to strike longitudinally, and cause a more extensive injury to the skin. When a bullet strikes the shaft of a bone, it cracks or splinters it, and either remains or passes through the cancellated ends. In its course the ball may carry before it pieces of cloth, coins, or other foreign bodies, which increase the danger of the wound. Many persons who have been shot during the excitement of battle describe the sensation as resembling the sharp stroke of a cane; but in most instances the wounded man soon begins to tremble as if in an ague-fit, complains of cold, his face becomes pale, his pulse scarcely perceptible, and he appears as if about to die. This is the condition termed *shock;* and though death sometimes does ensue during this state of prostration, it is not so serious as it appears, and the patient will probably pass out of it in a few hours with the help of stimulants and rest. Although excessive bleeding is not so common after gun-shot as other kinds of wounds, it may occur immediately to a fatal extent if assistance be not afforded. This assistance any one can give; it consists simply in placing the fingers in the wound, and if the vessel can be reached, pressing them upon it, directed to the proper point by the warm gush of the blood. Should the wound be too small to admit the finger, a handkerchief may be tied round the limb above the wound, and twisted tightly with a stick. It is well to examine the wound, to ascertain the extent of the injury done, and whether there are splinters of bone or portions of dress lying in it, which should be removed. But neither the examination nor the removal should be attempted if they seem likely to aggravate the injury. The treatment is similar to that of other wounds, and consists in protecting the part during the healing stages, moderating inflammation by a cold-water dressing and soothing poultices, and hastening the last stages of cure by the use of stimulating lotions. See *Wounds*.

GUN-SLING.—A sling for lifting a gun off its carriage, or off the ground when placed under a gin or other lifting-machine. It is formed by splicing the ends of a length of white rope together, the dimensions of the rope varying with the weight to be lifted. For very heavy guns, chain slings are used. Guns should invariably be slung as short as possible. This becomes absolutely necessary when heavy guns are to be raised, otherwise the tackle will be "chock-a-chock" before the gun is sufficiently high to admit of the trunnions clearing the carriage.

GUNSMITH.—A maker of small-arms; one whose occupation is to make or repair any small fire-arms; an Armorer.

GUN-STICK.—A stick to ram down the charge of a musket, etc.; a rammer or ramrod. This term is now rarely employed.

GUN-STOCK.—The part of a gun to which the barrel and lock are fastened. It is usually of walnut: in Europe the *Juglans regia*, in America the *Juglans nigra*. Gun-stocks, until the invention of the Blanchard lathe, were made by hand in a laborious and tedious manner. This machine was introduced into the Springfield Armory about 1820. A rough chunk of wood is placed in the first of the stocking-machines, from whence it emerges with its sides cut to the proper shape for turning. In another machine its butt-end is sawed, and a diagonal line cut at the breech. The third, armed with two circular saws, fashions the upper part of the stock in its finished form. Another machine reduces the butt to its ultimate shape. Another simply planes various places in the sides of the stock as points for the working of other machines, an operation which is known as *spot-*

ting. A sixth machine performs six distinct items, called *grooving* for the barrel, breech-pin, and tang, *heading* down, *milling*, and *finish-grooving*. The stock is at this stage prepared for the *fitting* in of the barrel. A seventh machine planes the top, bottom, and sides; while the eighth and ninth do the *shaping* and *bedding* for the butt-plates. The next machine prepares the stock for the reception of the locks. Another machine is used to cut for the guards, to bore for the side-screws of the lock, and two more to make places for tips and bands. After these various operations comes the second turning and smoothing of the work; then the grooving for the ramrod; then the boring for the ramrod from the point at which the groove ends. These machines are each provided with a pattern or templet, which is the exact counterpart of the cavity or other form to be produced in the stock. They are furnished also with cutters or borers, which, being placed above the stock, are made to revolve rapidly, and cut the wood in exact imitation of the pattern below. The movements of the tool are controlled by a guide which is inserted within the pattern. The tool is made to revolve by means of small machinery within its frame, the latter and all within it moving together with both lateral and vertical motions, being governed by the guide, which is connected with it, by the aid of very curious and intricate machinery. The work of the artisan, when the machine is in motion and the stock is adjusted in its bed within it beneath the borers or cutters, is simply to bring the guide down into the pattern and move it about the circumference and through its center. The cutting-tool follows the movements of the guide, and the result is a perfect duplicate in the stock of the form in the mold below. See *Lathe.*

GUN-STONE.—A stone used for the shot of cannon. Before the invention of iron balls, stones were used for shot, but are now altogether superseded.

GUN-TACKLE.—The arrangement of blocks and ropes for the means of raising and lowering guns. There are two of this name used in the artillery service. One consists of two double blocks, called a *gun-tackle*, the other a *heavy gun-tackle*, consisting of a double and treble block. In the former, the power is increased fivefold when the standing end of the *fall* is made fast to the movable block, and fourfold when made fast to the other. In the latter, the power increases five or six times, as used.

GUNTER CHAIN AND SCALES.—The chain and scales commonly used by military engineers. The chain is 66 feet, and its convenience in practice turns on the fact that ten square chains make one acre.

Gunter's Chain.

The chain is divided into 100 links, and thus 100,000 square links make an acre.

The name of *Gunter's Scale* or *Gunter's Lines* is usually given to three lines to be seen on almost any sector, and marked N, S, T, meaning the lines of logarithmic *numbers*, of logarithmic *sines*, and of the logarithmic *tangents*. To understand their construction and use requires a knowledge of logarithms; they are explained in every school-book of practical mathematics. The distances of the divisions marked 1, 2, 3, etc., on the line of logarithmic numbers represent the logarithms of those numbers—viz., 0, .301, .477, etc.—taken from a scale of equal parts. The other lines are constructed on an analogous plan. Calling to mind that multiplication of numbers is effected by the addition of the logarithms, division by their subtraction, involution by their multiplication, and evolution by their division, we are able to perceive with what ease many *rough* problems in areas, heights, cubic contents, and other matters may be performed through the agency of Gunter's scale.

GURGES.—A charge in Heraldry, meant to represent a whirlpool. It takes up the whole field, and when born proper is azure and argent. Also written *Gorges.*

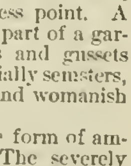
Gurges.

GURRIES.—The common name for mud-forts in India. These forts are frequently constructed near dwellings and where there is an absence of rock and

Gurry.

timber. They are quickly thrown up, and form a safe point of retreat in case of danger. The drawing shows one of these forts as constructed by General Howard on the Prairies of Idaho and Montana during the Nez Percé Indian Campaign of 1877.

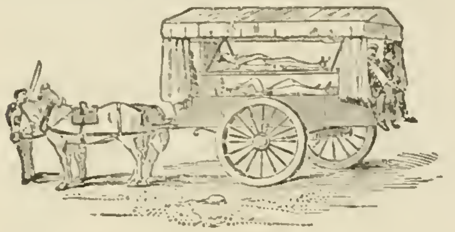
GUSSET.—1. A piece at first of chain, and afterwards of plate-armor, intended as a protection to the vulnerable point where the defenses of the arm and breast left a gap. 2. In Heraldry, the gusset is enumerated as one of the abatements or marks of disgrace for unknightly conduct. It is represented by a straight line extending diagonally from the dexter or sinister chief point one third across the shield, and then descending perpendicularly to the base. Heralds tell us that the gusset dexter indicated adultery; the gusset sinister, drunkenness; and when both were borne, it was because the bearer was faulty in both respects. Cowardice was indicated by an abatement called the gore sinister, which, though somewhat similar, we are told carefully to distinguish from the gusset, and which consists of two arched lines drawn, one from the sinister chief, the other from the middle base of the escutcheon, meeting in the fess point. A gore like a gusset represents a detached part of a garment; and according to Guillim, gores and gussets "are things in use among women, especially semsters, and therefore are fit notes of cowards and womanish dispositions." See *Gore.*



Gusset.

GUTHRIE AMBULANCE-CART.—The form of ambulance used in the English army. The severely wounded are laid on it at full length, while those slightly hurt sit in front and rear, and on the sides.

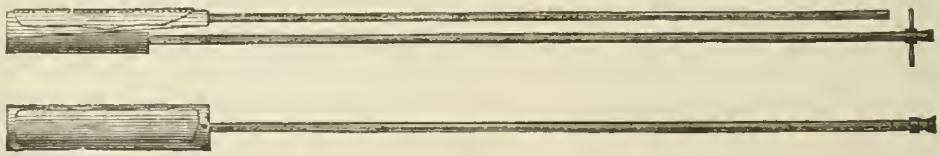
A stretcher is slung from the top for the accommodation of the former. The back-board is let down for cases requiring amputation. The hospital-chests are lashed underneath. After the battle of the Alma, in which 1986 British officers and soldiers were killed or wounded, Lord Raglan, who was almost without ambulances and draught-animals, was much embarrassed for the means of dealing with his poor suffering men; the conveyance of them down to the beach for shipment to the military hospitals at Scutari was



Guthrie Ambulance-cart.

a work of delay and misery to all concerned. Since then ambulances have been fitted up with all medical appliances, and a certain number have been attached to regiments. The latest pattern ambulance-cart in the British army is constructed to carry seven sick or wounded men—viz., two inside on the stretchers, two seated beside the driver, and three seated in the rear. One ambulance is allowed to each regiment, and fifteen to each division. See *Ambulance.*

GUTTA-PERCHA IMPRESSIONS.— Gutta-percha impressions of a portion of the bore of a gun are conveniently procured by means of wooden blocks or wedges. For this purpose two blocks are used, one about two thirds the length of the other; the longer block carries the gutta percha for the impression, the shorter one is used as a wedge. Each block has a staff longer than the bore of the gun, enabling the operator at the muzzle to place the blocks in any desired position in the bore, drive the wedge, and withdraw the blocks. These blocks are so shaped as to form an imperfect cylinder whose diameter is less than that of the bore, enabling the longer block to carry the gutta-percha to the required place in the bore. By driving in the wedge, the diameter of this cylinder is increased nearly to that of the bore; the gutta-purcha is pressed against the surface of the bore, and forced by the driving wedge to take the impression. Before taking an impression the gun should be thoroughly washed out and oiled with a well-oiled sponge; the gutta-percha, softened by hot water, just below the boiling-point, to the required consistency—about that of putty—is then placed on the block, well oiled, worked and kneaded with oil until it is spread over the required portion of the block. The blocks are also well oiled, particularly the surfaces which come in contact. The two blocks are put together at the muzzle, and both together are pushed into the bore to the distance desired, marked on the staff of the carrying-block. The carrying-block is held steadily by its staff, while the wedge-block is driven in by several blows of a sledge on the end of its staff; from two to five minutes is sufficient to allow it to set. The wedge-block is withdrawn first and the carrying-block with the impression afterwards. To withdraw the wedge-block, an iron pin is run through the staff near the end, and struck with the sledge until it starts, when it is easily withdrawn. The carrying-block will generally fall or release itself by its own weight, bringing the impression with it, if the impression is taken anywhere in the upper half of the bore. Where an impression is wanted from the bottom of the bore, a small block or rider is pushed in at the same time as the carrying-block, so as to keep the gutta-percha from touching the surface of the bore while being pushed into place. Afterwards the rider-block is withdrawn, the wedge driven in, and after the wedge is withdrawn the rider-block is pushed back close to the carrying-block, and acts as a fulcrum by which the impression is raised free from the bore, when both may be withdrawn together. In taking an impression on the side, it is better to push in the blocks as in taking the impression above, and then to turn the blocks to the side. Unless the block under the gutta-percha is well oiled, some difficulty may be experienced in releasing the impression from the block. The carrying-block should have a slight raised edge on each side of the upper surface of the block, to prevent the gutta-percha from spreading out too much when undergoing the pressure from the wedge, and also to protect it when turning the blocks for a side impression. Impressions are marked by their distance from the muzzle in inches; the name, number, and caliber of the gun, and whether taken at top, bottom, right, left, top right, top left, bottom right, bottom left, of the bore, when facing the muzzle. A convenient size to obtain the gutta-percha is in slabs twenty inches long, five inches wide, and five eighths of an inch thick. Each slab will make, ordinarily, two or three impressions, and can be used several times if desired. The defects are noted in the following manner: The distance is recorded in inches from the muzzle, and the position around the gun is recorded in every case according to the diagram, looking from the muzzle, as "up," "D," "R," "L," or in intermediate positions, as "R of D," "L of up," etc., etc. If a defect extends any length, it is noted as in the following examples: "36 inches, D to L," which means defect thirty-six inches from the muzzle going round the bore from "down" to "left;" or "49 inches to 56 inches up," meaning a defect running along the top of the bore from forty-nine inches to fifty-six inches; or, what is the same thing, seven inches long.



See *Impression-taker*, *Inspection of Ordnance*, *Ordnance*, and *Vent-impressions*.

GUTTE—GUTTY.—A term in Heraldry, from the Latin *gutta*, a drop, said of a field, or any particular charge on the field, covered with drops. When the drops are red, they are supposed to represent drops of blood, and the bearing is said to be *gutté de sang*. In this case some great suffering or labor, such as fighting for the recovery of the Holy Land, is indicated. Where they are blue, again, they represent tears, and the bearing is said to be *gutté de larmes*. When white, they are called drops of water, and the bearing is described as *gutté de l'eau*; but Nisbet is of opinion that tears are intended in this case also, and that repentance or penitence is signified by both.

GUTTERING.—The scoring or erosion observed at